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NATURAL RESOURCES AND ECONOMIC DEVELOPMENT[1]

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THE preoccupation of economists and other social scientists with the phenomenon of economic development, especially in the so-called underdeveloped countries and increasingly since the end of the second World War, has resulted in a spate of literature concerning the developmental process.[2] This literature displays an extraordinary diversity of interpretations and hypotheses regarding economic growth, suggesting the deep-seated uncertainty about its character and the causal factors which together may account for it. Increasingly, moreover, recourse has been made to economic history for data with which to study and forecast the course of economic growth in both developed and underdeveloped countries.

The contributions of geographers to consideration of these problems, however, have been few. This is all the more surprising since one of the major factors entering into the course of economic development—natural resources—is of particular concern to them. Furthermore, the areal differentiation of economic conditions and prospects has long been at the heart of economic geography.

This paper presents some reflections on the role natural resources play in the course of economic growth, especially in the lesser developed regions of the world. The basic questions it asks are: How important are natural resources in the course of economic development, and what relationships do they bear to

[1] This paper was prepared originally for the Institute for Economic Development at Vanderbilt University in July, 1956. I am indebted to R. R. Wohl, Hubert G. Schenck, and Richard Hartshorne for a reservoir of ideas which were applied to the original paper. Since then, valuable suggestions have come from other colleagues at the University of Chicago: C. C. Colby, Chauncy Harris, B. F. Hoselitz, Edwin Munger, and Gilbert White, and from H. P. Minsky of Brown University. In addition, Professor Hoselitz made available an advanced copy of a report written by him (with L. J. Lerner and R. S. Merrill) for the Special Committee to Study the Foreign Aid Program in the United States Senate: "The Role of Foreign Aid in the Development of Other Countries" (prepared in the Research Center in Economic Development and Cultural Change, the University of Chicago, and published as committee Print No. 3, March 1957, by the U.S. Government Printing Office).

[2] Among the publications of particular interest are: N. S. Buchanan and H. S. Ellis, *Approaches to Economic Development* (New York: Twentieth Century Fund, 1955); S. H. Frankel, *The Economic Impact on Under-Developed Societies* (Oxford: Basil Blackwell, 1953); B. F. Hoselitz, ed., *The Progress of Underdeveloped Areas* (Chicago: University of Chicago Press, 1952;) S. Kuznets, W. E. Moore, and J. J. Spengler, eds., *Economic Growth: Brazil, India, and Japan* (Durham: Duke University Press, 1955); W. Arthur Lewis, *The Theory of Economic Growth* (London: George Allen and Unwin, Ltd., 1955); W. W. Rostow, *The Process of Economic Growth* (New York: W. W. Norton, 1952); Jacob Viner, *International Trade and Economic Development* (Glencoe: The Free Press, 1952), and certain issues of the *Annals* of the American Academy of Political and Social Science, especially that of May 1956, "Agrarian Societies in Transition." In 1951, the journal *Economic Development and Cultural Change* was founded at the University of Chicago to provide an outlet for research papers dealing with problems of economic development. In addition, there have been a number of recent studies concerned with food, population, and economic growth, several of which will be reviewed in the *Annals* shortly. Of special interest among these are Richard L. Meier's *Science and Economic Development* (New York: John Wiley and Son, 1956) and the PEP report, *World Population and Resources* (London: George Allen and Unwin, Ltd., September 1955).

other factors which enter into the developmental complex? No attempt is made to provide a complete conceptual framework within which geographic research on development problems can be pursued more meaningfully, but the conclusions may help prepare the foundations for such a structure.

THE MEASUREMENT OF DEVELOPMENT

The terms "developed" and "underdeveloped" have by no means been defined precisely. If we adopt the broad interpretation of "development" as meaning the maximization of all available resources (in the economist's sense, whether "natural" in origin or not), then no country can be termed "developed," since none can demonstrate completely efficient use of all its assets. The United States, the U.S.S.R., and the Western European countries, as well as Afghanistan, all may be considered "underdeveloped" in this sense.

Commonly, therefore, the terms are defined on a comparative basis. The criterion most commonly employed is that of *per capita national product*, that is, the value per person in a given country or region of all goods and services produced in one year by its total population. National product (or income)[3] per capita provides an index to the state of an economy and to the position it occupies along the continuum between "development" and "underdevelopment." In this connection, it is important to point out that these two terms refer specifically to economics. They in no sense represent value judgments concerning the non-economic achievements of any society.

Per capita national product clearly is a better indicator of economic conditions than gross national product, which ignores the essential relationships of population to national economies, and tends toward bias in favor of countries with large populations, whatever their demographic characteristics.[4] For example, in 1955 India was estimated to have a gross national product of 27.4 billion dollar-equivalents (slightly more than Canada), which ranked it seventh among the nations of the world. In terms of national product per capita, however, India ranked next to China among the major nations, near the lowest levels of the scale; the figure assigned it ($72) was only about three percent that for the United States. Per capita national product, therefore, is an index to individual levels of living, and these in turn are assumed to reflect the state of economic well-being.

It also is an index particularly applicable to the measurement of *rate* of economic growth and the degree to which economic production is keeping ahead of or following behind population growth. A country's economy may be expanding rapidly, as reflected in a growing gross national product. On the other hand, individual incomes and levels of living may decline if population is increasing more rapidly than gross national product. This point is of crucial importance in the cases of the densely populated underdeveloped regions, such as India or China, where the rate of economic growth must exceed the rate of population increase by a considerable margin if economic difficulties are to be resolved and economic growth is to become self-generating. In other words, the individual worker under such circumstances must be able to "save" (or have put aside in his stead) enough capital to enlarge the productive facilities of the country sufficiently, after his own wants are satisfied, to permit expansion of the means of production at an accelerating rate.[5]

The range of "development" among coun-

[3] Frederic Benham, in his *The National Income of Malaya, 1947–9* (Singapore: Government Printing Office, 1951), pp. 3–6, provides a succinct explanation of the terms "national product" and "national income." He points out that the two aggregates are the same, except where payments are made abroad (in either direction) for reasons other than the provision of goods and services (remittances to China from Malaya would be an example). Such payments normally are small relative to the total aggregates. More important, production data normally are more abundant than consumption data, thus encouraging the use of national product as an economic indicator. In the case of Benham's study, despite its title, the data employed are production rather than income data.

[4] Mr. Leo Silberman points out that a measure defined in terms of per capita *adult* population would be an even better indicator since it would reflect real productivity and not discriminate against countries with high birth rates and/or large numbers of persons below 15 years of age. The logical extension of this reasoning would be an index based upon product per member of the labor force, but both of these tend to hide the significance of large families in given societies.

[5] Hoselitz, *et al.*, estimate that "an economy can break out of the vicious circle of poverty and underdevelopment only if it succeeds in allocating a minimum of 15 per cent of its gross national product for capital investment." *Op. cit.*, p. 6.

tries, as measured in these terms, is enormous. In 1955, for example, the United States is reported to have had a per capita national product of $2,343; Sweden, $1,165; the United Kingdom, $998; the U.S.S.R., $682; Italy, $442; Colombia, $330; Japan, $240; Mexico, $187; Egypt, $133; Thailand, $100; the Central African Federation, $61; and China (exclusive of Taiwan), $56.

These estimates of per capita national product have been mapped on Figure 1.[6] If we assume quite arbitrarily that a per capita product under $300 defines "underdevelopment," then we find that the underdeveloped peoples dominate the world, not only in area, but also in numbers. Almost all of Asian Asia, all of Africa except the Union of South Africa, and most of Latin America fall into the underdeveloped category. Included are some 1,780 million people, roughly 68 percent of the world's population.[7]

PROBLEMS OF COMPARING RESOURCES WITH PRODUCT

The preceding discussion is designed to introduce the problem of evaluating the importance of the natural resources factor in the developmental process. If we assume that per capita product is a sound indicator of stages of economic development, then what is required is an analysis of the relationship between the natural resource endowment and per capita product or income in different countries or regions. Unfortunately, for a number of reasons this seemingly practical approach is fraught with difficulties, and indeed may be misleading or impossible.

In the first place, the very concept of national product (or income) per capita is elusive, and its measurement is extremely difficult. The data supplied by ICA are in U.S. dollar-equivalents, converted from local currencies at the official exchange rates. However, the greater purchasing power of the dollar in certain countries may markedly alter the indicated rank-ordering along the continuum between "development" and "underdevelopment." Differences between the real and official value of the dollar also may explain in part the enormous discrepancy in product value between the United States and Canada on the one hand, and certain of the western European countries on the other.

Furthermore, and this may be far more significant, the data assume value systems in non-Western societies which are similar to those in the West and place high monetary value on the same sorts of goods and services.[8] In addition, the data for the lesser developed regions vastly understate the importance of goods and services about which we know little, but which may be of great importance to the natives of those regions. This understatement, together with the value-system objection, is exemplified in the case of Pakistan, for example, where the per capita product is estimated at 56 U.S. dollar-equivalents annually. If we assume that the consumption requirements of the Pakistani in any direct way resemble those of Americans, then we also would have to assume that there would have to be many fewer Pakistanis than there now are, since most of them would be dead or dying of starvation and exposure. The actual per capita production in Pakistan, therefore, must, on the one hand, be far greater than it appears to be and, on the other, be of quite

[6] These data are derived from the Office of Statistics and Reports, The International Cooperation Administration, and appear as Appendix I in the report by Hoselitz, *et al.*, *op. cit.*, pp. 81-2. Since data for a few areas were not available, as for Outer Mongolia, North Korea, Southwest Africa, Bechuanaland, Madagascar, North Vietnam, French Guiana, and certain of the eastern European communist countries, estimates have been made from trade and other data of the value of national product. The crudeness of these estimates does not, however, alter substantially the world pattern of development and underdevelopment.

[7] The distribution of "underdevelopment," or what might be called "economic problemness," presents a fascinating prospect for geographical analysis. Observe the association of the underdeveloped countries for the most part with the lower latitudes; their concentration north of the 30th parallel in the Americas and the 40th parallel in Eurasia; the splendid isolation of Australasia; the fact that, apart from Europe, it is the former "vacant" lands of the New and Australasian worlds which have become most developed economically; the colossal concentration of "underdevelopment" as opposed to the nearly as imposing localization of "development"; and the contrast between the two, the "West" on the one hand and the rest of the world on the other. Some of these observations will be expanded upon in a later paper.

[8] Frankel, *op. cit.*, pp. 31ff. In his discussion, Frankel points out the hidden assumption underlying many universally applied indices to national production and income, such as Colin Clark's, that societal differences "would not affect the purposes for which [an individual] desires or spends income."

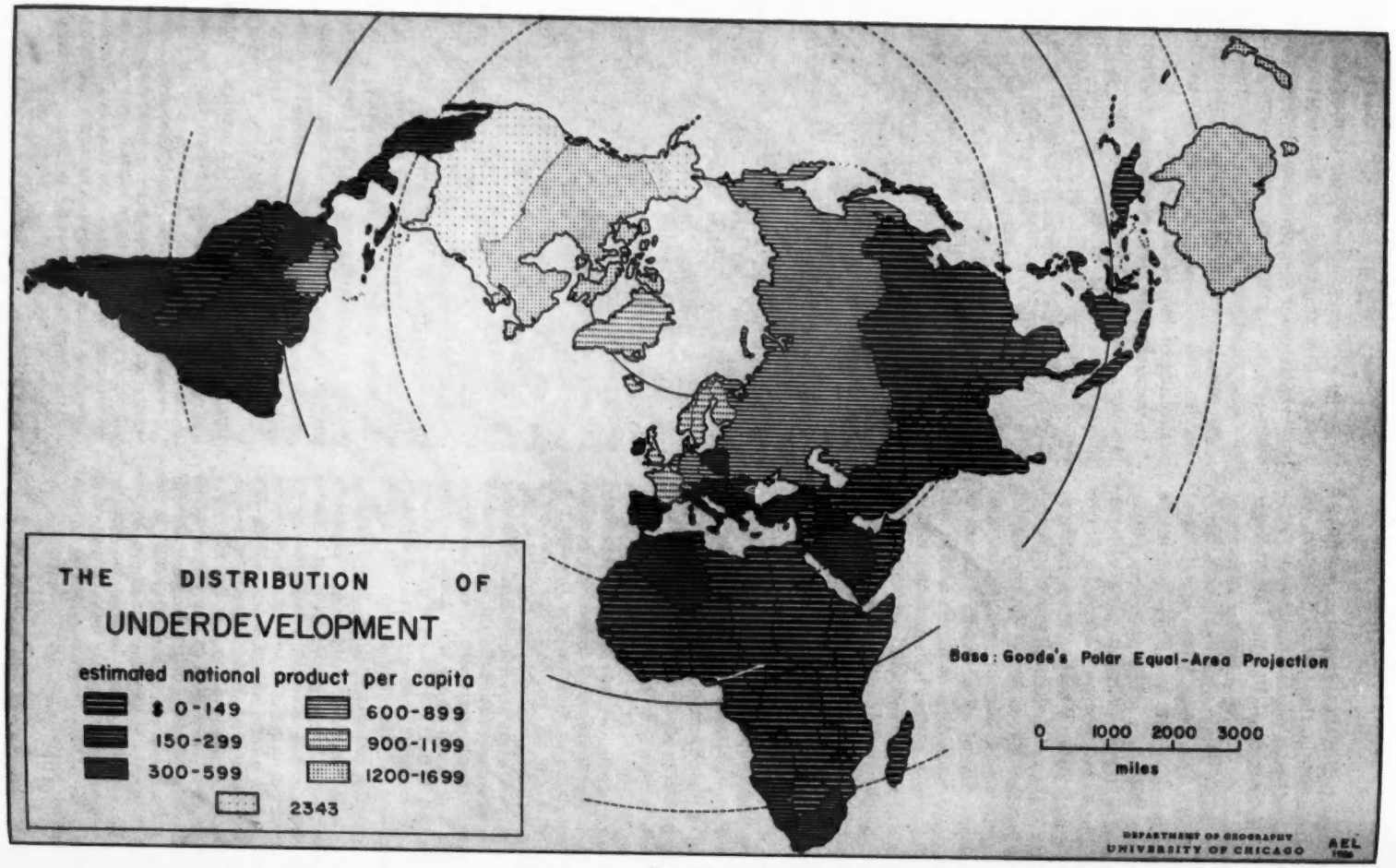
THE DISTRIBUTION OF
UNDERDEVELOPMENT
estimated national product per capita
$ 0-149
150-299
300-599
600-899
900-1199
1200-1699
2343
Base: Goode's Polar Equal-Area Projection
0 1000 2000 3000
miles
DEPARTMENT OF GEOGRAPHY
UNIVERSITY OF CHICAGO
AEL

FIGURE 1.

a different character than that of the West in order to explain the continued existence of the Pakistanis themselves.

Finally, data concerning national income and production are of the very roughest order for many countries of the world. Indeed, it is only the countries of the West for which reasonably accurate national production and income data are available. The very data upon which the indicator to develop is so often based, therefore, are in themselves highly suspect.[9] Indeed, the degree to which data concerning economic phenomena are available provides almost as useful an indicator to economic development, or lack of it, as the indicator itself.[10]

In spite of these objections, per capita national product provides a rough and useful indicator, probably the best single indicator, of the stage a country has attained on the economic developmental scale.[11] If for the moment we accept it in this light, why cannot we proceed directly to relate natural resources to it? The objections are two. First, as Kuznets makes clear, "comparison requires reduction to a common denominator." In the case of economic development there is an index—per capita capital national product. What comparable index can be used to measure resources? One conceivable measure would be the extent of their utilization per capita and the nature of their exploitation. But utilization is in turn a covariant of the same economic processes for which per capita income is an index. It would be meaningless to compare one aspect of a process with another aspect that varies virtually identically with it. What we probably would be saying is a simple truism: that more highly developed regions (as defined in terms of high per capita production) exploit their natural resource endowments more effectively per capita (or per capita member of the labor force) than those less highly developed. Thus, the "common denominator" of which Kuznets speaks would become the very relationship we are trying to measure. The difficulty, of course, lies in the lack of a suitable alternative index to intensity of natural resource utilization, which can be compared directly with per capita indices to economic development.

Second, any development of indices to the utilization of natural resources presumes a substantial knowledge of the resource base itself, but attainment of this knowledge is circumscribed rigidly by the relative paucity of resource inventory data on a world-wide basis. Such inventories represent one of the primary needs for developmental planning in the lesser regions.[12] Even if such inventories were in existence, however, the problem would remain of developing an index comparable to that for economic development itself. It would mean developing common denominators for such varied resources as hydroelectric energy, soils, drainage, growing season, etc. Since these vary in significance from society to society, from place to place, and from time to time, the development of such indices may prove insurmountably difficult.

This does not mean that we can afford to neglect natural resources in considering the economic realities or potentialities of a given country, despite the example of Switzerland which is called on interminably to illustrate the essential insignificance of the resource endowment to the development of a given region. The fact that orchids technically can be grown in greenhouses in Antarctica does not mean that hothouse agriculture is going to play a significant role in the development of that

FIGURE 1.

[9] The complexities inherent in estimating national products and incomes in underdeveloped areas are described in Benham, *op. cit.*, especially pp. 3–22.

[10] As H. P. Minsky points out, however, available data often may reflect regulation by government. If the United States were to become committed to a policy of free trade, for example, the quantity and quality of the data about U.S. trade might well deteriorate.

[11] One alternative is direct measures of levels of living, but creation of such measures presents enormous difficulties and drawbacks. For a discussion of these problems, see *Definition and Measurement of Standards of Living*, "Report of a Conference of U.S. Experts Convened 30–31 January, 1 February, 1953, Presented to the Secretary-General of the U.N." (Chicago: Public Administration Clearing House, 1953), mimeographed; and *Report on International Definitions and Measurement of Standards and Levels of Living* (New York: United Nations, 1954, E/CN. 3/179 and E/CN. 5/299).

[12] Food and Agricultural Organization, *Land Utilization in the Tropical Areas of Asia and the Far East*, Development Paper No. 17, January 1952, 10 pp. This booklet presents an outline of the need for resources inventories to precede agricultural and general developmental planning. See also F. L. Keller, "Resources Inventory—A Basic Step in Economic Development," *Economic Geography*, January 1953, pp. 39–47.

continent, although under presently unforeseeable circumstances, it might. At our present stage of knowledge, comparisons simply cannot be made between indices to natural resources and per capita indices to attained or potential economic growth, since the former do not yet exist and the latter need to be further refined. All that can be attempted, perhaps, are relatively imprecise and qualitative evaluations of the relations between natural resources available at any one time to any one region and the various other elements which together bear upon the course of economic development. Such evaluations, however, demand some explanation of these several elements and their interrelations.

MAJOR FACTORS IN ECONOMIC DEVELOPMENT

The classical economists spoke of at least three major factors of production—land, labor, and capital. To these may be added at least two other determinants of economic development—technology and cultural configurations. These factors and determinants will be examined briefly in their reverse order, a reordering which may suggest, but does not define, their significance in the developmental process.

By *cultural configurations* is meant that system of social organization, combined with constellations of values, goals, or objectives, which all societies possess in different combinations. These social systems vary among societies, sometimes only to a modest degree, often sharply.[13] Without resorting to Parsonian terminology, it is clear that some societies are oriented towards goals which emphasize individual initiative and the production of goods and services beyond basic needs. In such a society wants tend to be unlimited, and the entrepreneur becomes a symbol of the means through which these wants may be satisfied and in turn expanded. In other societies, in contrast, material wants may be prescribed within a relatively inelastic cultural configuration to which the entrepreneurial spirit is alien.[14] These model conceptions are, of course, not wholly realistic, but they serve to suggest that in some societies rapid or accelerated economic growth is actively demanded, whereas in others it may not be sought. If a presently underdeveloped country (as measured in terms of very low per capita product) is to develop rapidly, it must have a "will" to develop.[15] That "will" must be possible within the context of its value system, or its value system must be changed, since it lies at the center of institutional barriers to both economic and cultural change. The relations of these observations to natural resource use are direct and clear. Use implies *consciousness* of need and the *will* to invest in the effort required to exploit a given resource.[16] Without them, resource development will not take place, except by outsiders.

Awareness of need, moreover, implies both a knowledge of the uses to which given resources can be put and an understanding of the ways by which those resources can be made available to meet those needs. This knowledge and understanding may be subsumed under the heading of *technology*. All societies, of course, possess a technology, and some of these have made possible the production of surpluses which have introduced economic flexibility into the social system, but historically these technologies have differed

[13] For a provocative taxonomy of social organizations and the values associated with them, see Talcott Parsons, *The Social System* (Glencoe: The Free Press, 1951). A brief summary of Parsons' system is given in Kuznets, Moore, and Spengler, op. cit., pp. 379–84.

[14] The contrasts in attitudes toward natural resources, as between these two types of societies, are discussed by Alexander Spoehr in his chapter, "Cultural Differences in the Interpretation of Natural Resources," in W. L. Thomas, Jr., ed., *Man's Role in Changing the Face of the Earth* (Chicago: University of Chicago Press, 1956), pp. 93–101. In many non-Western societies man is regarded as part of a total "natural" environment over which he has little control. The Western conception is of a universe of animate and inanimate forces which can be "made to serve man's needs and wants."

[15] The idea of a collective "will" must be used with caution; otherwise it may de-emphasize unwisely the innumerable independent judgments and decisions within the framework of a given social system which result in economic and social change. See Frankel, *op. cit.*, pp. 74–75.

[16] In a personal communication, Edwin Munger points out that "not only must [a] society be conscious of the need and have the will to invest, but that investment often demands a rearrangement of the value system to provide incentive and reward for the handful of entrepreneurs who spark the change. Somehow, a climate for creativity must be created. I mean creativity [as] observation *plus* action. Westerman has suggested [for example] that the wheel . . . was invented repeatedly in West Africa, but that jealousy combined with the grip of the secret poison societies would wipe out the advance."

conspicuously among themselves. What is meant here, moreover, is a more specifically Western technology, that combination of scientific knowledge and practical engineering which goes by the name "know-how" in the propaganda of American assistance agencies.

Perhaps the most significant aspect of this Western technology is its mobility.[17] All *literate* peoples can *in time* acquire it. Furthermore, it is cheap and rather easily available.[18] Its transfer, however, often may be slow, unless imported in the persons of foreign advisers. These can in turn direct the exploitation of natural resources in ways which probably were not possible by means of indigenous technologies and in directions of use which might not even have been contemplated before.

The fluidity of technology has long acted, in fact, somewhat to the advantage of countries of lesser degrees of development in that they may be able to incorporate into their industrial establishments the latest technical improvements and thereby make these establishments more efficient than the older plants in the already developed countries. It is not unlikely, all other things being equal, that the three new steel plants being constructed in India under British, Russian, and German supervision, respectively, will be among the more efficient in the world, although the differences in organization and tooling among them may in the long run be a national disadvantage rather than advantage. In this connection it also is conceivable that a lesser developed country can practice economies of scale by sizable "crash" programs of development in narrow sectors of its economy, whether they be agricultural or industrial, given suitable availability of other factors of production, especially capital.

If imported skills and services can be purchased relatively inexpensively with the third element of the five—*capital*—other needs for economic growth usually cannot be purchased so cheaply, and large capital accumulations are agreed generally to be necessary if economic development is to be rapid. The accumulation of capital is one of the major difficulties of the lesser developed countries, since many of them are characterized by value systems which place a low premium on saving and a high premium on the allocation of such surpluses as are available to ends that are capital-disseminating rather than accumulating. All, by definition, are characterized by low per capita incomes, which probably mean small surpluses to begin with.

Capital can be acquired and accumulated, however, in several ways— at least in the short run by (1) importation in the form of loans or grants, as in the case of many recipients of aid from the United States or the Colombo Plan countries, for example; (2) the squeezing of living standards to or even below the subsistence level, as was the case in the Soviet Union and may be the case in China; or (3) the rapid creation of surpluses through the application of rapidly acquired technology to given resource endowments.

The third method can take place on one of two levels, either (a) through the improvement of traditional methods of production, as in the case of agriculture and sericulture in immediately post-Meiji Japan, or (b) through the introduction of new technologies directed toward the exploitation of hitherto unused resources, the production of which then can be exported.[19] Here, the examples of Saudi Arabia, Kuwait, Iraq, and Venezuela, and the ex-

[17] Mobility may be characteristic also of non-Western technologies, but some of the latter are not recorded in written form, which fundamentally restricts their circulation.

[18] I am not suggesting that the transfer of technology is easy, cheap, or quick to pre-literate peoples, nor in cases where literacy rates are low. It is, of course, true that you can lead a man to a book, but you cannot make him read it, if (a) he cannot read or (b) it is in a foreign language he does not understand, even though he may wish to know what is in it. Illiteracy characterizes many of the underdeveloped regions, and the costs of its elimination are high, but the degree to which illiteracy needs to be overcome before accelerated economic growth is possible is a highly controversial question. I am assuming here that the transfer of technology can take place, initially at least, among a relatively small number of persons, both donors and receivers. In many instances the problem is less one of literacy in absolute terms than of translation facilities and the adaptability of a language to new expressions. Chinese and Japanese are examples of languages into which translations often have been difficult.

[19] New crops may be included under the term "new technologies." In this sense the cultivation of cacao in the Gold Coast by native cultivators for export is a good example. Even more striking is the role of coffee production among the Chagga of Tanganyika on the slopes of Kilimanjaro. See E. S. Munger, "African Coffee on Kilimanjaro: A Chagga *Kihamba*," *Economic Geography*, April 1952, pp. 181–85.

ploitation of their petroleum resources provide striking examples, as do the mining of gold and diamonds in South Africa. *The role of natural resources in these situations is that of an agent for rapid capital formation,* which may be directed toward ends not directly related to resource utilization, such as improvements in public health and the spread of literacy.

Variations in the quality of public sanitation and medical care or education in turn substantially modify the character of our fourth major factor, *labor.* It is a truism that in order to economically develop, there must be people to develop economically, and their effectiveness as a labor force will vary almost directly with their numbers, health, skills, and discipline. In relatively "new" areas of pioneer settlement, where ratios of people to developable resources are low, every addition to the labor force means a major increment in regional product. This is particularly important when the additions to the labor force are skilled, rather than unskilled. As Hoselitz, Minsky, and others have noted, the rapid economic expansion of the United States from the middle of the nineteenth century on was in no small part due to the massive imports of "capital" in the form of some of Europe's most skilled workmen, although this form of capital does not appear in capital import figures.[20] The recipient country in such cases also is spared the costs of supporting and training the technician until such time as he is able to contribute to the economy; these costs are borne by the "exporting" country.

However, labor not only produces, it consumes; and in many of the great lesser developed regions the effectiveness of the labor force as a means for increasing productivity is hampered by its very numbers and the very high ratio of population to exploited resources. The stagnation which may be associated with these conditions is exaggerated by the wastage of human energy and the discouragement of ambition by seasonal underemployment, ill-health, malnutrition, and a combination of ignorance and poor technology. The vicious circle of stagnation can be broken, it is true, but only by the introduction of new technologies which substantially alter the relations of labor to the natural resources it exploits, at costs of varying dimensions and at the initiative of foreign or indigenous elites which represent a discontinuity with traditional cultural configurations.

It is clear that the course of economic growth is singularly complex and the factors which enter into it are mutually interdependent. It is not correct to say, as some cultural anthropologists might, that indigenous cultural configurations alone determine the nature of economic growth; nor can one support the geographical determinist, if such there be, who would maintain that the nature of the physical environment (or the resource base) directs the course of economic progress. All elements move together, often disjointedly and arhythmically like a man on crutches, but, in sum, in one direction.

NATURAL RESOURCES: THE FIFTH ELEMENT IN ECONOMIC DEVELOPMENT

If these intimate interrelationships can thus be demonstrated, and if each of these elements in economic growth varies with each of the others, then our fifth variable, *natural resources,* becomes a concept as elusive and dynamic as any of the other four. To the geographer, natural resources in their broadest sense include all the freely given material phenomena of nature within the zone of men's activities, at present a zone extending about twelve miles above the surface of the earth and about four miles below it, plus the additional nonmaterial quality of situation or location. The association of these elements of land, air, sea, and situation in a single area commonly is identified as its "resource base" or "resource endowment."

This definition is misleading, however, in that it assumes a complete knowledge of the ways in which the physical environment may be utilized. This knowledge is in no sense complete, and, in the words of Zimmerman, much of the environment is in fact composed of "neutral stuff" awaiting awareness of its possibilities and the development of technologies which can exploit it effectively.[21] The dimen-

[20] The author's father exemplifies the case. By the time he migrated to the United States, he had completed his general education and acquired most of the technical training which permitted him to earn a livelihood as a skilled tool and die maker almost immediately upon his arrival in this country.

[21] E. W. Zimmermann, *World Resources and Industries* (New York: Harper and Brothers, 1951), rev. ed., p. 8.

sions of these understandings and the abilities to exploit the resource base, however defined, vary with cultures, with time, and with space. It is necessary, therefore, to distinguish between resource potentialities and a resource endowment both available and understood.

In East Asia, for example, there tends to be a seemingly remarkable neglect of upland areas, that is, of those areas either not suitable for paddy cultivation or convenient for the production of dry crops, even under topographic, climatic, and edaphic conditions which are matched by many productive agricultural areas elsewhere in the world.[22] In large part this condition reflects technologies which are unable to cope with the conditions that exist in the upland areas or which are at least better suited to the physical conditions characteristic of the lowlands. The result is a system of agricultural production geared to the better lands which produce more per unit area at the cost of staggering labor outputs and which, at the expense of seasonal underemployment, suffer labor shortages at the key periods of planting and harvesting.

In the time dimension, resource variations are illustrated by the Great Plains, the rich grassland soils of which were almost entirely neglected by the Plains Indians and which now are one of the great granaries of the world. Another example is the fertile prairies of central Illinois, which at first were neglected by the white settlers from southern Indiana, Kentucky, and Tennessee, who first settled in the more familiar narrow, wooded fluvial lowlands which infrequently scar the smooth prairie surface.[23] Variations in time also may reflect simply the exhaustion of a given resource; witness the ghost mining towns of Colorado or the abandoned farms of western Oklahoma, where the fertile topsoil was partly removed by wind erosion, and drought completed the destruction of what might have been productive grazing lands under careful range management.

Existing resources may remain in the potential category also because of inaccessibility. Inaccessibility may reflect a technical inability to withdraw a material from its matrix of associated elements, as until recently in the case of titanium, one of the new wonder metals. Or it may reflect a simple lack of external economies, as in the case of some ten percent of Japan's forest reserves which remain unexploited because of a lack of transportation facilities.

This point leads to another *caveat* regarding the above definition of natural resources. If a given resource is not accessible, it cannot be described as "freely given," since it cannot be exploited without investment of "capital" in one of its several forms. The qualification may be extended to almost all resources, since they must be acted upon in order to become useful to men. It follows that many resources, as they come into use, are no more "natural" than they are "cultural." Is a long-fertilized, irrigated, and cultivated soil or a planted stand of Japanese cedar "natural?" Only to a degree, of course. We can conceive, therefore, of a classification of resources based upon their degree of "naturalness" in which classification would take place perhaps according to the amount of capital required to make them available.

Two other characteristics of resources remain to be noted. The first is their substitutability, the second their complementarity.

Changes in technology mean changes in resource uses and in a sense competition among resources for given uses. The substitution of certain plastics, some based upon coal, for metals provides one illustration. At one time also the tin can was made of tin plate, that is, sheet steel dipped into molten tin; at a later stage electrolytic tin-plating permitted major savings in tin through much thinner tin coatings over the steel; now many so-called "tin cans" are coated with a fine film of tin only on the outside and are lined with plastic on the inside. In addition, glass containers compete with the "tin can" as a means for packaging foodstuffs. Substitutability has its geographic aspects as well. A given resource in one area that cannot bear the costs of distant transport may be substituted for in another by a more abundant resource. For example, Philippine mahogany or *lauan* and other tropical hardwoods replace genuine mahogany in parts of Asia; and in many Asian countries the ubiquitous bamboo provides an inexpensive scaffolding nearly as efficient and far less costly

[22] See the two volumes, *The Development of Upland Areas in the Far East* (New York: Institute of Pacific Relations, 1948).

[23] Each of the above examples illustrates cultural differentiation of resources as well. See Spoehr, *op. cit.*

than the timber, aluminum, or steel scaffoldings used in the middle-latitude West.

Finally, resources tend to complement each other, to be linked in a chain of utilization patterns and of productive processes in which the production of one demands or effects the production or availability of others. The mining and use of iron ore in steel manufacturing demands limestone and coal; the strip-mining of coal destroys valuable farm land in southern Illinois or southeastern Kansas; the clean-cutting of timber in forested areas in Japan is reflected in the silting of reservoirs downstream; and the development of hydroelectric installations in the Columbia River has accelerated the diminution of the salmon fisheries off the coasts of Oregon and Washington. Not only may resources be linked into a complex of productive processes, but also, as Colby has suggested,[24] the development of facilities for the exploitation of any one resource may make possible the utilization of an entirely unrelated resource. He cites the example of branches of the Southern Pacific Railway from Ogden, Utah, to San Francisco, which were constructed to provide access to the gold, silver, and copper ores of Nevada, but which then made possible the development of a profitable grazing industry centering in oasis-like settlements along the lower flanks of the mountain ranges crossed or paralleled by them.

It is a characteristic of the more highly developed and industrialized economies that they can take into account and integrate complementary resources into systems of production. *In this sense, they are less specialized, less fragmented, and more flexible in terms of resource use than the lesser developed economies in which extreme specialization of resource utilization tends to be practiced* partly because of less highly developed and therefore less flexible technologies. Even the Chinese, advanced as they were a millenium and more ago in the control of water, cleansed the silted channels of their irrigation systems simply by dredging or flushing out the silt periodically; integrated watershed control of water supplies, though known, was not practiced. In effect, the use-possibilities among resources are fewer than in the more highly developed economies.

[24] In a memorandum to the author.

ECONOMIC DEVELOPMENT IN RELATION TO NATURAL RESOURCES

The nature of resource utilization in any society depends upon, and in turn reflects upon, the nature of the economic development that is taking place within it. This development varies, however, with the size and nature of the unit under examination. The question may be phrased: "The economic development of what?" As Kuznets points out, we ordinarily would not seriously discuss the resource development problems of an Andorra or a Monaco.[25] Nevertheless, problems of economic variability arise for minute areas.

For example, Singapore, a British Crown Colony, is well on its way to independence within the Commonwealth. As a politically autonomous unit, Singapore, an island only 26 miles from east to west and 14 miles from south to north, is endowed with a minimum of significant natural resources. It consists of one great metropolis rapidly expanding its urbanized area, surrounded by wasteland and intensively cultivated Chinese market gardens and fishing villages which supply it with only a minute fraction of its food requirements. Its major natural resource, one most difficult to measure quantitatively, is its situation astride the chief maritime gateway between the Indian Ocean and the South China Sea. This situation, combined with certain qualities of British institutions in the area, such as political stability, a sound currency, and an elaborate system of shipping and banking services, plus the entrepreneurial enterprise of its largely Chinese population, make a viable economic future conceivable, much as in the commercial city-states of the Hanseatic League. Even though politically autonomous, Singapore as a great regional commercial center and entrepôt will be economically dependent on political and economic conditions wholly beyond its control. The point here is the relative irrelevance of natural resources other than situation as a positive factor in the economic development of such a city-state. In a negative sense, however, the absence of a resource endowment and a virtually complete dependence upon the outside world for subsistence is a crucial factor in determining Singapore's ability to survive world economic depressions and political trans-

[25] Kuznets, Moore, and Spengler, *op. cit.*, pp. 4ff.

formations over which it has no control.

On the other hand, one can point to a tiny state, such as the Sheikhdom of Kuwait, only 1,930 square miles in size and mostly unproductive desert, which is riding the crest of a rising national income almost entirely from petroleum production alone. Here the significance of a single natural resource is overwhelming.

Nevertheless, under normal circumstances, it is reasonable to postulate that the larger and more varied the resource base of a given state, the more opportunities it will have, *ceteris paribus*, for rapid economic development. All of the major industrialized countries have, or have had, relatively large and diversified resource endowments, and the United States is perhaps the most striking example. But even the United States is far from self-sufficient in natural resources, and lesser political units are even less so.

This being the case, would it not be more productive in the long run to consider the economic development of some supranational unit, such as the British Commonwealth, or Western Europe, or the Latin Americas?[26] The prewar Japanese Empire was such a unit and was self-contained to a surprising degree, a degree hidden in part by the fact that Japan's prewar trade statistics did not include her most important trade orientations, those toward her dependencies—Korea, Taiwan, Karafuto, and later Manchuria.

Consideration of such supranational units of economic organization is beyond the scope of this paper, but one major point emerges from a consideration of them, that is, the distinction between the actual possession of a resource endowment *in situ*, and *accessibility* to resources which may be under the control of foreign states. Trade and transportation are the devices by which inequalities among nations in resource endowments may be minimized; but they can be minimized only at a cost. Every country dependent upon foreign areas for certain of its raw materials must be able to pay for them and for such services as transportation, banking services, and insurance which are necessary in order to make them available.

How can these payments be made? For those countries which already are highly industrialized, capital may be obtained from the production of processed and manufactured materials and services which may be exported in partial payment for needed raw-material imports. In the lesser developed countries, however, this option is unlikely to exist. Payment for imported foodstuffs and raw materials, as well as the manufactured goods which make domestic resource exploitation in part possible, depends in part on the availability of products, usually raw materials, suitable for export. In this context, mineral resources, food surpluses, and forest products tend to play an inordinately important role, at least for short periods of time.[27]

In addition, the exploitation of certain resources and the availability of their products for export often require considerable investment in external services of which transportation may be the most important. Indeed, accessibility means transportation. In the highly developed regions internal transportation systems have long since been developed, and external communications facilities in the form of national merchant marines also may have been created. In the lesser developed regions, however, these types of services often do not exist.[28] As a result, known resources may remain unexploitable, costs of imports will remain high, and raw material exports may be disadvantaged on the world market. Grants and loans from foreign sources provide another source of capital, but grants tend to be few, and loans must be repaid. The importance of loans should not be minimized, but ultimate development depends upon a country's own savings, internally organized, unless it is to become in-

[26] The productivity referred to here is solely economic. Integration may be practiced on a large scale for non-economic reasons. An example proposed by Munger is that of Portugal and her overseas dependencies for which integration is practiced only "by rigidly controlled departures from the world price system. . . . The values to the Portuguese are political not economic." From a communication to the author.

[27] The export of labor and remittances from nationals abroad are other sources of income, *e.g.*, remittances to China and Lebanon from nationals overseas, or miners from Mozambique employed in the mines of South Africa.

[28] In reality, the dimensions of these facilities vary markedly from country to country. In India, for example, the railway system developed by the British may be regarded as a "freely given, non-natural" resource inherited from its colonial past by a free India.

tegrated fully into a larger economy as a constant recipient of foreign aid.

Problems of this kind indicate the need for rational planning whereby economic development can be guided. Unfortunately, planning often reflects the erroneous assumption that economic development in lesser developed countries must follow the patterns of development which took place in the new developed regions, and that resources and the nature of their utilization are fixed. However, even in comparing the patterns of economic growth in the already developed and industrialized countries, significant differences in the developmental process are apparent. The relatively gradual economic growth characteristic of Great Britain has not been duplicated since. As Gerschenkron points out, early British industrialization took place without the large-scale participation of banking interests or government[29] and was financed primarily by an accumulation of wealth derived from trade with a great empire and to a degree with the remainder of the world as well. In Germany, France, Italy, the U.S.S.R., and Japan, among others, rapid economic growth took place under the leadership either of giant banking interests or of the state.

It is apparent that the nature of economic growth will vary within each unit under consideration and with the time at which accelerated economic growth begins. Indeed, the rates of growth that are either possible or desirable also will vary notably with place and time and with the five major determinants of economic development previously discussed. The reordering of comparative advantages in resource endowments as a result of new technologies, trade barriers, or intervening resource discoveries of necessity changes the possibilities and potentialities of resource use and planning.

Recent changes in power technology provide a useful illustration. According to Hartshorne, not one of the major industrial nations is or was without access to major sources of energy, particularly the mineral fuels. Britain acted as the coal mine of the world for a period of time, and it is worth pointing out as well that at the time it entered upon its period of modern economic development, Britain was unusually well-endowed with other resources, such as iron ore, tin, and certain lesser minerals, and even timber with which to construct a merchant marine. Germany, France, and Russia also were well-endowed with energy resources. Other countries, such as Italy, short of energy resources *in situ*, were able, albeit at a cost, to obtain mineral fuels from outside their boundaries, or they developed hydroelectric potentials to an exceptional degree. That the availability of energy raw materials has not induced economic development, however, is illustrated by the numerous underdeveloped areas well-endowed with such resources—India is one example; China another.

More important, perhaps, is the future availability to the underdeveloped countries of energy from atomic reactors. At present this energy is not cheap, especially in the small units which are likely to be better suited to the needs of most of the lesser developed countries. However, such energy will become available, if not now, then within the next several decades. This does not mean that the development of more traditional energy resources should be delayed; quite the contrary, since these may remain less costly, given accessibility and high quality, for a long period of time. It does suggest two important considerations, however: (1) that planning for energy and other natural resource development in the "have" countries must be kept flexible and constantly subject to review, and (2) that the "have-not" countries possess possibilities for economic growth based upon ample supplies of energy that previously were unthinkable.

CASE STUDIES

Many of these various aspects of economic development and of the role of natural resources particularly—the variations that result from differences in the nature of the resource base, from differences in economic and political structure, and from differences in the state of the world economy at given times—may be illustrated by the comparative histories of Japan, Taiwan, Malaya, and to a degree, China and India.

Japan.—Japan's modern economic development began late and with a marked socio-economic discontinuity after the fall of the Shogunate and the restoration of the Emperor

[29] B. F. Hoselitz, ed., *The Progress of Underdeveloped Areas*, pp. 13-14.

in 1867.[30] At that time, Japan was a country living right up to its then known and developed resource endowment, and emerging from a 200-year period of virtual isolation. Japan's resource endowment, then and now, is relatively niggardly. Arable land accounts for considerably less than 20 percent of the total land area, as compared with 40 percent in France, and the actual area under cultivation at present is not more than 15 percent of the whole. Soils are of indifferent fertility; growing seasons are long enough in most of the country to permit double-cropping, except in the highlands and in Hokkaido in the north, but they are not long enough to permit the double-cropping of paddy. Forest resources were then relatively abundant, though they now supply about 75 percent of Japan's wood needs only at the cost of their gradual diminution. Mineral resources are abundant in variety, but few are of great commercial significance, and coal, low-quality though it may be, is the single most important mineral resource. Hydroelectric potential, however, is relatively high for a country of its size, about 148,000 square miles, the size of Montana, and the Japanese have developed the larger part of it already.

At the time of the Meiji Restoration, moreover, the press of a population of about 35 millions on these resources under then prevailing technologies was high, and population had remained virtually unchanged for a number of years. Nevertheless, Japan was able to develop economically with enormous rapidity. How was this accomplished?

One thing is certain. The initial stages of the developmental process were financed primarily internally. Foreign loans and capital investment were very small, if strategic. Accumulation of domestic supplies of capital was made possible by the extraordinarily rapid development of the natural resource base and rapid increases in productivity from it. Until after the Sino-Japanese war, Japan's chief source of revenue was raw silk. Quite small investments in sericulture, especially in standardizing the quality of silk output and in increasing silk-reeling capacities, resulted in Japan's displacement of China as the world's prime supplier of raw silk and in the rapid expansion (resulting partly from greater purchasing power in Western Europe and the United States) of the world silk market. At the same time, similarly small investments in agriculture through the provision of improved seed varieties, irrigation facilities, better transportation for marketing of agricultural products, and more fertilizers, resulted in agricultural surpluses, the profits of which were siphoned from the countryside by the government through improved tax mechanisms (forced saving), making possible the more massive participation of the state in providing external economies, in investing in alternative productive sectors of the economy, in restricting consumption in the rural areas, and in permitting the rapid growth of large urban complexes with their supplies of labor for modern industrial enterprises. It is even true that the Japanese cotton-textile industry was based originally on Japan-grown cotton, which was in adequate supply until the eighties when a sufficiently modern industry had been developed to require large imports of cotton from abroad. It was the textile industry, first silk and then cotton, that permitted rapid economic growth in Japan. It is safe to say also that the application of easily available improved technologies to the then Japanese resource base so increased its potential as to create surpluses for internal consumption and export. These then permitted the initiation by Japan of a program of heavy-industry development, later financed in part by foreign loans and capital as well as by an expanding export trade.

These assertions may be controversial, especially in light of the substantial inadequacy of Japan's resource base to support the present Japanese economy, but they should be regarded as partial justification for the previous description of natural resources as a means of capital formation and for the admonition that resource planning is a continuing process that varies with the needs and objectives of a given country and the changes in world resource equilibria.

Taiwan.—The developmental history of Taiwan has taken place under different circumstances and with different results. Taiwan is a relatively small island about one-fourth the size of Illinois, with an indigenous Chinese

[30] For a detailed description see W. W. Lockwood, *The Economic Development of Japan* (Princeton: Princeton University Press, 1954) and his chapter in Kuznets, Moore, and Spengler, eds., *op. cit.*, pp. 129–78. See also Edwin P. Reubens' chapter in *ibid.*, pp. 179–228.

population of about 8 millions. Under the Japanese, both gross national product and per capita product rose rapidly. These increases in production also may be said to have been internally financed by more efficient utilization of the island's natural resources, especially agricultural resources.[31] Although only about a fourth of the island is topographically suitable for agriculture, soils are relatively fertile in that fourth, water supplies are relatively abundant, and the growing season permits double-cropping of paddy all over the island, except in the highest highlands. The Japanese invested sizable sums in Taiwan, but at the earliest stages these were designed more to promote political and military stability than not; at a later time, the evidence suggests that investment was far smaller than the value of the surpluses that continued to be produced from Formosan soil. Despite a rising population, agricultural production under the guidance of Japanese technical advisers backed by political authority forged ahead of population increases and permitted the export to Japan of three-quarters of a million tons of rice and a million tons of sugar each year. Some additional development took place in the mining of coal, but especially in the development of hydroelectric resources, which in turn made possible the establishment of aluminum and ferro-metallic processing plants. Consumers' goods, such as textiles, continued to be almost entirely imported.

At the close of the war Taiwan was separated from Japan. It possessed a highly developed agrarian economy which specialized in food crops, was commercially rather than subsistence oriented, and possessed sizable surpluses with which to finance more diversified economic development. Had all other factors remained constant, it is reasonably certain that these surpluses, based upon further improvements in the utilization of agricultural resources, would have permitted the establishment of a viable economy, either as a region of China or as an independent political unit. The great advantage was what we might call a "time-cushion" in the form of surpluses for export by means of which economic planning could have been financed and implemented despite the other limitations of the resource endowment.

Unfortunately, all other things never are equal, and Taiwan's population was swelled by 2,500,000 refugees and troops from China proper, who consume many of the agricultural surpluses and demand capital expenditures on the part of the two governments on the island, which further hamper economic growth. At the same time, the withdrawal of the Japanese agricultural technicians, believed to have numbered up to 20,000 and the diminution of political stability resulted in substantial declines in production which were not overcome until about 1952.

Taiwan still possesses a "time cushion," but its dimensions are much smaller than they were. Economic growth is taking place, and at a rapid rate, but in part by means of major grants-in-aid, which do not require repayment, from the United States. The island's economy is still primarily agrarian, although the reasonable limits of the development of the resource base with given technologies are beginning to be reached, and the significance of other factors is beginning to dominate the scene.

Malaya.—The third and quite different example also concerns what might be termed a "colonial" economy, that of Malaya, due for independence in 1957.[32] Unlike the relationship between Japan and Taiwan, that between Britain and Malaya never was so intimate, on either economic or political grounds. Malaya's economy, apart from the commercial functions of Singapore, is clearly dual, and was so from the earliest period of British hegemony. One major sector is Malay, indigenous, primarily agricultural and subsistence, based upon the cultivation of paddy by Malay villagers in restricted areas and secondarily upon Malay fishing activities. The second major sector is basically foreign in that it is managed and manned by non-Malay labor and financed by non-Malay capital, is commercial, and is export-oriented. It in turn is divided into two basic subsectors—one, the production of rubber; the other, the mining of tin. Each of these

[31] For a more detailed examination of this problem see N. S. Ginsburg, *Economic Resources and Development of Formosa* (New York: Institute of Pacific Relations, 1953), mimeographed.

[32] A detailed handbook covering Malaya by N. S. Ginsburg and C. F. Roberts, Jr., is to be published in the fall, 1957, by the University of Washington Press, under the auspices of the American Ethnological Society.

major sectors displays a notable direct reliance upon the existing resource base of the country. But unlike Taiwan, where there is a time cushion based upon surpluses of foodstuffs, the time cushion in Malaya is of quite a different sort, as is the role of the resource endowment in future development.

Malaya does not feed itself. Indeed, it imports more than half of its food supply. The predominantly food-producing Malay community, 49 percent of the total population, produces enough food only for itself and until very recently existed in relative isolation from the other communities in Malaya. Rubber and tin production have been primarily the result of foreign enterprise and labor—British, Chinese, and Indian. If Malaya were self-sufficient in foodstuffs *and* had the surpluses of tin and rubber for export, there would be an abundance of capital for internal development and for the provision of the increasing social services that are being demanded of the government. These considerations are apart from the huge drains on the Federation budget of the anti-communist campaigns.

Actually, there is capital available from the rubber and tin industries, and Malaya has been the Commonwealth's prime dollar earner, but the need for food imports to meet normal consumer needs means a much more gradual pace of economic development. This pace must vary also with the fluctuating prices for rubber and tin on the world market and the dependence of the colonial export economy upon forces beyond its control. This does not mean that Malaya's resource endowment is poor. Actually, its potentials are poorly understood as yet, and superficially the country is prosperous as compared with most lesser developed regions. But the *nature* of the resource planning and development problem is distinctly different from that in Taiwan where food supplies from domestic agriculture are adequate. In Malaya, a sudden and marked drop in both tin and rubber prices would be disastrous, and levels of living would fall in proportion, with concomitant political unrest. In short, the circumstances surrounding the utilization of the natural resource base are markedly different and require differing measures both of analysis and of policy implementation.

China and India.—On quite a different scale China and India possess still other developmental problems relative to their resource endowments.

Each of these countries is characterized by largely agrarian societies, with strong subsistence qualities, and by heavy pressures of population upon known and available resources. There are in effect no food surpluses; indeed there often are deficits. Both are following roughly similar courses of economic growth, though implemented in markedly different ways. Agricultural resources are being developed by the application of technological devices, more so in India it is true than in China, but the need may be greater there. Heavy industry is receiving the greater part of the emphasis in their developmental planning, although lighter industries in both countries have had a rather lengthy history of growth. Both have abundant supplies of energy in the form of coal, China more than India; both have reasonably large non-fuel mineral resources.

They differ substantially in the ways in which economic measures are implemented, as is to be expected when one, India, is essentially democratic, and the other, China, is totalitarian. Their greatest similarity, however, lies in the inflexibility imposed upon their developmental planning and policies by the necessity for increased agricultural production, not as a means for capital accumulation, but simply to prevent starvation, maintain a healthier labor force, and discourage rural (and therefore national) unrest. Both illustrate the degree to which high man-land ratios act as a deterrent to accelerated economic development.

CONCLUSIONS

From these preliminary statements concerning the role of natural resources in economic growth follow a few relatively simple generalizations:

(1) The possession of a sizable and diversified natural resource endowment is a major advantage to any country embarking upon a period of rapid economic growth. Diversification may be less important than the dimensions of one or more resources, if their reserves are large enough and long-run demand is steady and strong.

(2) Resources need not be situated within the confines of the country undergoing development, but they must be accessible. Accessibility implies transportation, and trans-

portation in part implies imports, both of which demand accumulations of capital with which to obtain materials from extra-national or discontinuous resource endowments.

(3) One of the major means for capital accumulation is an abundance of easily exploitable natural resources (Saudi Arabia, South Africa, Venezuela).

(4) In no sense, however, are natural resources responsible for development and economic growth; they possess no deterministic power. However, "they possess latent utility and are part of an over-all regional capability."[33]

(5) They also may set limits upon the approaches to natural resource planning and development. If a given raw material necessary for some phase of industrialization is not located *in situ* and is unavailable due to tariff barriers or high transportation costs, modification of that phase is likely. Or, if rapid rises in agricultural, forest, or mineral production are possible, they may strongly influence the system of priorities and scale of operations which will characterize a total developmental effort or history.

(6) Even if abundant, natural resources will not determine the *kinds of uses* to which they will be put. Their availability in agriculture particularly, however, may influence critically the shift from agricultural to non-agricultural employments.

(7) The significance and functions of natural resources in economic development will differ markedly with the stages in the developmental process. Under normal circumstances the role of the resource endowment is most important in the earlier stages of economic development, when it acts as a means for capital accumulation and an accelerator for economic growth if abundant, and as a depressant upon that growth if niggardly.

(8) Similarly, the significance of indigenous resources is much less to the highly developed countries with their discontinuous world hinterlands and larger supplies of capital, skilled labor, technology, and entrepreneurial experience, than to the relatively lesser developed regions frequently characterized by scarcities of all these factors.

(9) Any comprehensive program for economic development demands the development of a sophisticated inventory of resource endowments, an appraisal of present systems of resource utilization, an analysis of cultural and physical obstacles to resource development, and an estimate of resource potentials, taking into account conflicting uses and demands for given resources and the probable role of technological change over periods of time.

[33] C. C. Colby.

A COMPARATIVE ANALYSIS OF THE DRY WESTERN LITTORALS[1]

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ALONG the western littorals of South America, southwest Africa, and northwest Africa are recorded some of the lowest rainfall totals on earth. Much speculation has been made about the causes for this extreme aridity, and several studies have been made of individual coasts. But these individual studies are limited in their conclusions by the scarcity of data from these areas and from an incomplete theoretical knowledge of the atmospheric processes at work. Synoptic analysis in most cases is impossible with the present reporting systems. Taken together with the western coasts of North America and Australia, in similar locations with respect to latitude and continental position, these dry coasts form a recurrent phenomenon over the surface of the earth, and suggest that a comparative study might well reveal the major controls of precipitation in all the areas and the relative magnitudes of the controls in each area.

[1] The author wishes to express his appreciation to Professor Glenn T. Trewartha of the University of Wisconsin who willingly gave his time and effort to assist in the original work from which this paper is extracted, and to Professor Morris Neiburger of the University of California at Los Angeles who made available the data from the cruises of the *Crest* and the *Horizon*.

[2] Now on leave at the University of California at Berkeley as a Ford Foundation Fellow in order to specialize on the Russian area.

SPATIAL COINCIDENCES AMONG SURFACE PHENOMENA

Figure 1 shows the five coastal areas in question arranged in comparable positions on

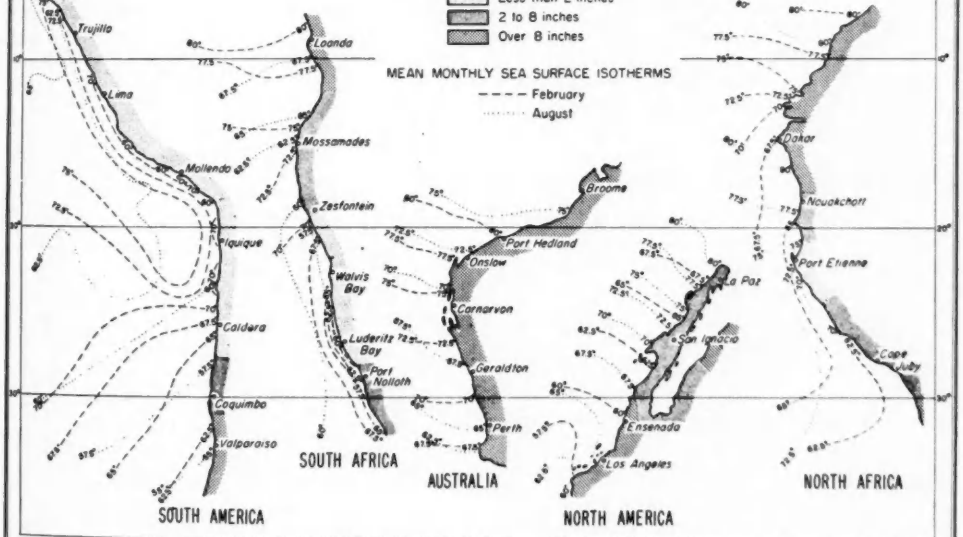

FIG. 1. Coastal Comparisons. All coasts arranged in comparable positions on Southern Hemisphere parallels. Sea temperatures from the *World Atlas of Sea Surface Temperatures.* Precipitation data from *Climatic Summary of the United States; Climate and Man; Naval Air Pilot Weather Summaries; Monthly Weather Review Supplements,* Nos. 31 and 32; *Publications of the Weather Research Center, Army Air Forces; Weather on the Coasts of Southern Africa,* prepared by the Meteorological Services of the Royal Navy and the South African Air Force, 1944; and for Australia, a personal communication from G. W. Mackey, Deputy Director, Meteorological Services, Perth, Western Australia.

southern hemisphere parallels. A comparison of the positions of the driest regions shown on this map with positions of major climatic controls operative in these coastal areas indicates some degree of coincidence among the arid regions, the atmospheric subtropical high pressure cells, sea surface temperatures, and the major oceanic circulations, although it is immediately evident that no simple relations exist between any two of the elements mentioned.

Coastal Precipitation and Subtropical High Pressure Cells

Using Mintz and Dean's[3] singular points of streamline divergence in each ocean to represent as accurately as possible the positions of the centers of the respective subtropical highs, the author plotted graphs showing coastal precipitation against distances and directions from the high pressure centers in an effort to bring to light relations which might be overlooked in cursory examinations of precipitation and surface air pressure maps. Plots were made of precipitation amounts against distances and directions from the subtropical high centers, and also with precipitation amounts for all coasts on the coordinates of distances and azimuth angles from the centers of the respective high pressure cells. A general pattern for all coasts was difficult to discern. It appears that precipitation remains approximately nil to great distances from the subtropical high center so long as the azimuth angle from the center increases accordingly, but when the angle remains essentially constant the precipitation increases with increasing distance. The only plots that suggested a definite relation were those of precipitation versus direction alone (Fig. 2); those of precipitation versus distance were particularly nondescript.

[3] Yale Mintz and Gordon Dean, "The Observed Mean Field of Motion of the Atmosphere," *Geophysical Research Papers No. 17* (Geophysics Research Directorate, Air Force Cambridge Research Center, August, 1952).

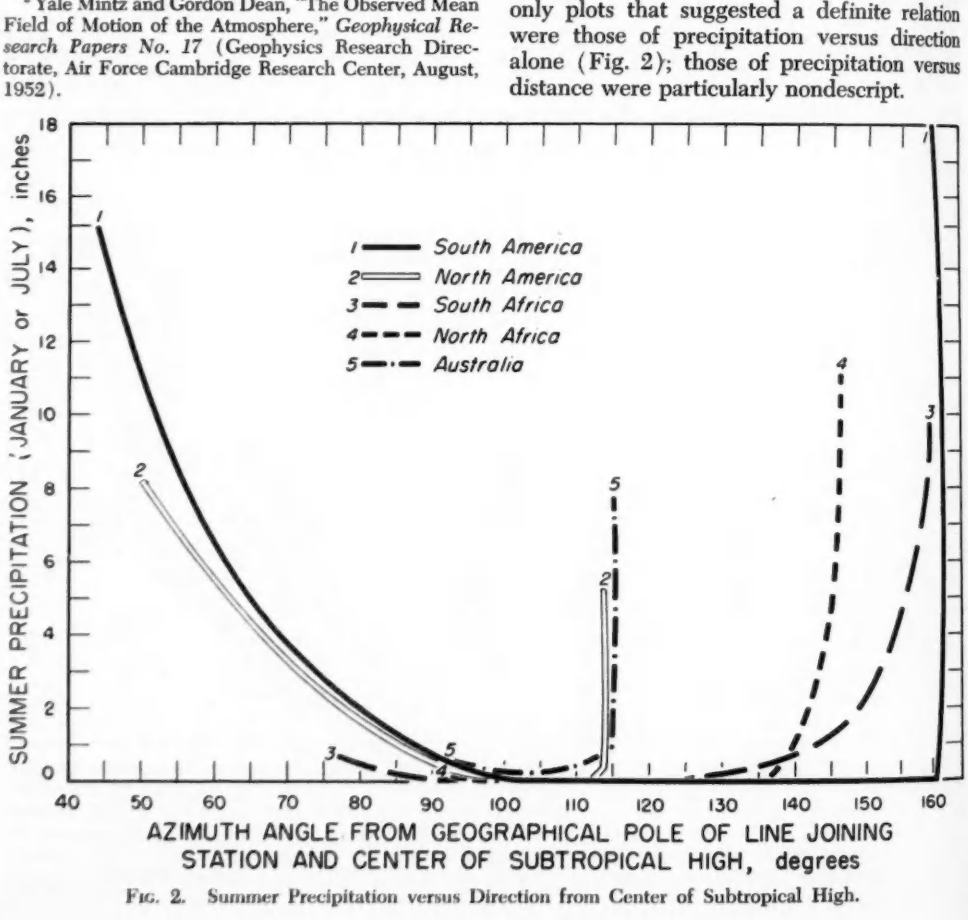

FIG. 2. Summer Precipitation versus Direction from Center of Subtropical High.

In Figure 2 the curves for all coasts are similar in form in that they each show an increasing rate of precipitation increase toward lower azimuth angles (higher latitudes) beginning at about azimuth 100°, and that they each, with the exception perhaps of south Africa, show an abrupt increase in precipitation amounts toward higher azimuth angles (lower latitudes) at some point along the coast where the azimuth angle from the high pressure center becomes approximately constant. This abrupt precipitation increase equatorward along each coast does not occur at any specified azimuth from the high pressure center, but occurs where the coastal configuration is such that the coastline becomes approximately parallel to the line joining the station and the center of the subtropical high. If one assumes the circulation around the high to be essentially circular, then at the point of abrupt precipitation increase the coastline is oriented approximately perpendicular to the atmospheric circulation with the prevailing wind blowing offshore. It would thus appear that the angle at which the major atmospheric circulation strikes the shoreline is more important than the direction or distance of the particular point from the subtropical high center. This suggestion will be elaborated upon later.

Coastal Precipitation and Sea Surface Temperatures

Correlation coefficients between simultaneous temporal variations of sea temperatures and precipitation amounts at most stations indicate no significant relation. However, as McEwen has suggested,[4] there might be a lag of several months after changes in oceanic characteristics have occurred before the effects on atmospheric conditions are evidenced. And rain-producing atmospheric circulations in these areas are often such as to produce advection of air on such a scale as to mask the effects of simultaneous sea temperature variations. Records of sea temperatures in most regions are too short and too discontinuous to allow for elaborate calculations of correlation coefficients between temporal variations of sea temperatures and precipitation amounts in an attempt to reveal significant relations between the two involving time lags, atmospheric synoptic situations, and the like. And in the driest areas where sea temperatures might exercise the strongest controls on atmospheric conditions, average precipitation amounts are so small that correlations between monthly, seasonal, or yearly variations for several years at any station are influenced too much by a few large variations for the coefficients to be representative.

More reliable are correlations between spatial variations of sea temperature and precipitation averages involving overlapping records of different lengths and periods from many stations as well as sea temperature reports from many ships, although these correlations will necessarily be primarily qualitative with only the most obvious relations identified. The three coasts with extended regions of less than two inches of annual precipitation—South America, southwest Africa, and northwest Africa—are the only west coasts which are paralleled by truly pronounced cold currents at low latitudes. As is shown in Figure 1, along these coasts areas of minimum sea surface temperature equatorward of 28° latitude either correspond latitudinally with areas of minimum precipitation or lie immediately poleward from them.

The rainier Australian coast has no pronounced cold current at any time of the year. Near shore, a very weak current can sometimes be detected which generally flows equatorward in summer and poleward in winter,[5] but average sea surface isotherms are deflected poleward along the coast during all seasons, indicating that along this coast the water is actually warmer than in the open sea to the west.

The cold waters along the North American coast are limited to more poleward latitudes where influences are masked by other climatic factors in an area which is subjected to numerous cyclonic storms and is quite rainy anyway. Minimum sea temperatures along the coast are found in the latitudes of northern California and Oregon where the rainfall averages 60 to 80 inches per year. At subtropical latitudes the isotherms are perpendicular to the coast of Baja California where the coastline diverges from the open-ocean circulation.

[4] George F. McEwen, "Seasonal Rainfall Forecasting Based on Pacific Ocean Temperatures," *The California Citrograph*, Vol. XVI, No. 1 (Nov. 1930), pp. 3, 22–23, 26.

[5] G. E. R. Deacon, "The Hydrology of the Southern Ocean," *Discovery Reports*, Vol. XV (1937), pp. 1–124.

It is not the absolute temperature but the anomalous character of the temperature and its rapidity of change along the coasts that show significant relations to precipitation amounts. The driest coastal regions of South America and Africa correspond almost perfectly with areas of maximum negative temperature anomalies,[6] and the steepest precipitation gradients along these coasts, in the vicinity of Guayaquil in South America, Mossamedes in southwest Africa, and Port Étienne to Dakar in northwest Africa, correspond with the steepest sea temperature gradients. The two driest areas, South America and south Africa, are bordered by areas of negative temperature anomalies both winter and summer. The largest negative temperature anomalies existing over the oceans occur along northern California in summer when that coastal area is experiencing complete aridity. In winter the same area shows positive anomalies and at the same time experiences considerable rainfall. No significant temperature anomalies exist along the rainier Australian coast.

Precipitation Variations Perpendicular to the Coasts

As far as can be ascertained from the relatively sparse data available, there is a narrow coastal strip not over 10 to 20 miles wide that is drier than the area immediately inland along all these coasts except that of Australia. It thus appears that some control conducive to aridity is operative in the immediate coastal areas beyond those operative in the general areas. Charts of rainfall frequency over the oceans[7] in a general way corroborate this hypothesis by showing that rainfall frequency also increases from the coasts out to sea. Profiles of precipitation perpendicular to the coasts in the immediate coastal areas are very difficult to ascertain because of paucity of recording stations; and coastal influences on precipitation, if any, are sometimes impossible to separate from influences of terrain features. One pair of stations showing an increase of precipitation inland would not be significant, but the fact that all data available without exception show an increase inland does seem to be quite significant. One would expect a precipitation increase inland along a coast such as South America where the terrain rises almost everywhere immediately from the coast, but even along the coast of northwest Africa where often the land elevations rise more gradually from the coast the data consistently show a precipitation increase inland.

In southwest Africa the coast between Swakopmund and Luderitz Bay has less than an inch of precipitation per year. But Kuibis, on the escarpment overlooking the Namib, has 3.5 inches, and there is a constant increase in precipitation eastward in spite of a decrease in elevation. There are very few recording stations between the coast and the escarpment in the Namib, but it has been ascertained that the isohyets parallel the coast, the isohyet of one inch being approximately 35 miles inland, and that of four inches about 70 miles inland.[8] Recording stations are not sufficiently close together within the driest coastal areas of North and South America to permit the drawing of similar conclusions for these continents, but at higher latitudes where data are more abundant the pattern appears to be the same: less precipitation in the immediate shore areas than inland. Along southern California, island stations consistently receive less precipitation than coastal stations and coastal stations receive less than inland stations, although admittedly here differences in elevation and exposure are such that general patterns of influence are difficult to discern. The complete consistency of all data in showing precipitation increases inland, however, appears to make the individual small increases significant.

All these data would seem to indicate that exposure to the sea is a significant factor influencing precipitation amounts in these areas. This influence must be exerted upon the atmosphere at the boundary surface and must be

[6] Maps of isanomalies of surface air temperatures have been drawn by Hann-Suring. For recent printing of these maps, see Trewartha, *An Introduction to Climate* (1954). Similar maps for sea temperatures are not available; however, simultaneous sea and air temperatures have a correlation coefficient of over 0.9, so that the distribution of one may be used to represent the distribution of the other.

[7] W. F. McDonald, ed., *Atlas of Climatic Charts of the Oceans*, United States Weather Bureau Publication No. 1247 (United States Department of Agriculture, 1938), charts 95-98.

[8] *Weather on the Coasts of Southern Africa*, Vol. II, Part 1, p. 36. Prepared by the Meteorological Services of the Royal Navy and the South African Air Force, June 12, 1944.

due to temperature and frictional relations between the sea and the atmosphere and the adjacent land and the atmosphere. Several aspects of these relations will be investigated later in the paper.

Precipitation and Exposure to the Major Oceanic and Atmospheric Circulations

Apparently more significant than mere distance or direction from the subtropical high centers or than absolute or anomalous sea temperatures in relation to precipitation totals is the degree of exposure to the major oceanic and atmospheric circulations. Although the horizontal fields of surface atmospheric streamlines and surface ocean currents are too ill defined, especially at low latitudes, to allow for a detailed analysis of their effects on the climate of adjacent land, the broader correlations between precipitation and the angle of impingement of the major circulations on the shorelines are fairly obvious. The surface atmospheric streamlines, and particularly the open-ocean currents, form rather smoothly curved circulations in their respective areas. Where the land projects into the major circulations and maintains contact with actively circulating open-ocean water and maritime air little precipitation occurs. Where the land recedes from the major circulations precipitation increases. The steep rainfall gradients in the vicinity of the Gulf of Guayaquil in South America, at the bulge of southwest Africa near Mossamedes, and south of Port Étienne in northwest Africa occur where the coastal configuration is such that the water and air from the open ocean no longer actively impinge on the shore, but diverge from it in an ever-widening arc, leaving an area of stagnant water and air between the major circulations and the shoreline.

The westward projection of the coast of South America north of Arica is such that contact with actively circulating open-ocean water is maintained to very low latitudes. Where the coast suddenly diverges from open water at the Gulf of Guayaquil a most abrupt increase in rainfall results. The dry Galapagos Islands off the coast of Ecuador might be considered an extension of the coastline along a path of constant curvature from Cabo Blanco on the Gulf of Guayaquil. The town of Guayaquil, beyond the turn of the coast, comes into contact only with the stagnant circulation of the protected Gulf and receives over 38 inches of precipitation per year. The entire coastal strip along the headlands of the Gulf of Guayaquil is semiarid, while only ten miles inland the climate becomes quite humid.[9] Nowhere else is the coastal configuration such that optimum contact with the open-ocean circulation is maintained to such low latitudes, and nowhere else does the dry area extend so far equatorward and the climate change so rapidly and so intensely from dry to wet.

Conditions along the coasts of southwest and northwest Africa are similar to those along South America, but since the African coasts diverge from the major circulations at higher latitudes, contrasts are not quite as sharply defined. Ascension Island forms a counterpart in the South Atlantic to the Galapagos in the Pacific. It represents a continuation of the dry climate on the coast in direct line with the major circulations which diverge from the coast at Mossamedes. St. Helena Island, 700 miles to the southeast, is not in line with the major circulations and receives much more rainfall—43 inches per year as compared to 5.5 inches at Ascension. Using islands so far removed from the coastal areas concerned might be extrapolation of analogy beyond reality, but consistency of results seems to indicate that the procedure is valid.

In the case of northwest Africa: Funchal, Madeira Islands, and Tenerife, Canary Islands, are conspicuously moister than are Casablanca and Cape Juby on the African coast at similar latitudes. And the Cape Verde Islands are drier than the African coast at their latitude. Thus, it appears that the longer the air trajectory over the water is, the less is the precipitation. The marine air coming in from the northwest passes over Madeira and the Canaries and reaches its maximum stability near the coast to the southeast; but farther south the return flow is from land to sea, and the coast is rainier than the Cape Verde Islands. The north African coast projects into the major circulations to latitude 21°, where it might receive maximum stabilization and greatest drought

[9] R. C. Murphy, "Oceanic and Climatic Phenomena along the West Coast of South America during 1925," *Geographical Review*, Vol. 16 (1926), p. 53. A small map of the Gulf of Guayaquil shows the boundary between a narrow coastal zone which receives rain only during wet years and the interior which receives rain annually.

(Port Étienne), but at this point it turns abruptly southward, diverging from the major circulations and losing possible maximum aridifying effects. The rainfall does not increase as abruptly at this point as it does in the Guayaquil area, perhaps because of the fact that Port Étienne is farther poleward where the stabilizing effects of the subtropical high pressure cell are more operative.

In North America, where the coast trends constantly away from the major circulations, maximum effect is lost south of 35° and the dry climate gradually changes to humid at a latitude of approximately 22°. The less arid condition on the coast of western Australia apparently is little related to oceanic conditions, for here the land is never in contact with an active circulation of open-ocean water.

The degree of dryness, latitudinal extent of the dry area, and abruptness of change of rainfall amounts at the extremities of the dry area on each of the five west coasts under consideration vary directly with the degree of juxtaposition between the coast and the major oceanic and atmospheric circulations. The coasts remain dry to low latitudes as long as they are in active contact with the major circulations, and they become humid when they diverge from the major circulations. The abruptness of change from dry to humid increases the lower the latitude at which the divergence between the coast and the major circulations takes place.

PHYSICAL PROCESSES LINKING PRECIPITATION AND PRECIPITATION CONTROLS

What are the actual processes that link these basic controls with the ultimate result: precipitation? If one could answer this, there would be no need for a comparative study. Unfortunately, such knowledge is largely lacking. The problem is infinitely complicated by the fact that the controls are interdependent. Certainly the fact is all-important to the aridity of the coasts that the subtropical high pressure belts are broken into cells of circulation with the average positions of their eastern termini approximately coincident with these western coasts. For, as already stated, the continued juxtaposition of the coast with the circulation around the subtropical high cell seems to be the prime requisite for aridity along the coast. The cellular circulation in each case provides for a flow of air parallel to the coast. This not only provides for maximum atmospheric subsidence over the coastal area,[10] but through its frictional drag upon the sea largely determines the major oceanic surface circulation and enhances surface contrasts between land and sea by inducing upwelling of cold subsurface water adjacent to the coast, thereby depressing the surface temperature of the water considerably below that produced by horizontal circulation from higher latitudes alone. In fact, it appears that in some instances, particularly at low latitudes, low surface water temperatures are due more to upwelling than to a cold ocean current coming from higher latitudes, because frequently "cold spots" exist in the surface water which are colder than surrounding water in any direction.[11] Also, at very low latitudes, as, for instance, the Gulf of Guayaquil, surface water temperatures rise almost instantaneously after the coast loses contact with the major circulations. Apparently the vertical circulation in the water ceases when the horizontal circulations are no longer present, thereby allowing for normal warming of the stagnant surface water by insolation.

Apparently most intense and consistent upwelling takes place where the coastline maintains active contact with the major oceanic circulation. Where the coast recedes from the major circulation, weak currents develop and some upwelling may be present, but cold water will occur only in local spots which probably are too limited in extent to have a pronounced effect on the atmosphere at it passes over them. In the following discussion the presence of upwelling of significant intensity will be assumed

[10] Mintz and Dean, *op. cit.*, p. 25, observe that maximum subsidence occurs on eastern margins of anticyclonic cells. This agrees with the Bjerknes concept of the tilt of high pressure cells.

[11] Such observations can be found in E. R. Gunther, "A Report on Oceanographical Investigations in the Peru Coastal Current," *Discovery Reports, XIII* (London: Cambridge University Press, 1936), pp. 205, 210–211; R. C. Murphy, "Oceanic and Climatic Phenomena along the West Coast of South America during 1925," *Geographical Review*, Vol. 16 (1926); *Mapas Mensuales del Litoral Peruano*, published by Compania Administradora del Guano, Departamento de Oceanografía e Ictiologia, Lima, Peru (maps showing average sea temperatures, air temperatures, barometric pressure, and winds in quarter-degree areas off the coast of Peru from 1939 to 1953); and E. Yale Dawson, "A Further Study of Upwelling and Associated Vegetation along Pacific Baja California, Mexico," *Journal of Marine Research*, Vol. X, No. 1 (1951), pp. 39–58.

wherever the coastlines and the major oceanic circulations are in active contact. This will help to explain the significance of contact between the coastlines and the major oceanic circulations. But, so far as oceanic influences on the atmosphere are concerned, sea surface temperatures are of prime importance. Whether cold sea temperatures are produced by upwelling or by some other means is immaterial. In this discussion upwelling will be tacitly assumed, but only the actual sea temperatures will be dealt with, and their influences on precipitation will usually be considered as an integral part of the total influences of surface contrasts.

Some of the physical processes operative along these coasts can be deduced from the data of aerological soundings which recently have become available and from a few studies dealing with specific aspects of these processes in limited areas. Many of the data which are available for use in air mass analysis along these west coasts have been taken along the California coast somewhat poleward from the coastal region in which this study is most interested. But since the data are primarily for summer and since summer conditions are fairly uniform along the North American west coast all the way from central Oregon to central Baja California, temperature lapse rates and inversion characteristics in the California area are quite typical of conditions within the driest coastal areas.

Detailed studies of processes operative in the California area in summer[12] reveal processes predominant in the driest areas most of the year and lend significance to the sparse air mass data which have been compiled in these areas. A typical lapse rate curve in the California coastal area shows a cool layer of air at the surface, the so-called "marine layer," which varies in thickness from zero to several thousand feet. Usually the thickness is not zero, but it is usually less than 2,500 feet. The lapse rate in this shallow layer is approximately adiabatic. Above this layer of air a strong temperature inversion exists, with a temperature increase sometimes as high as 30° Fahrenheit through the inversion layer. Above this, the temperature decrease with altitude is usually about equal to that of the U.S. Standard Atmosphere. In general the inversion base is lowest about 10 miles offshore and increases in height both toward the land and farther out to sea. During the summer it occurs at an average elevation of about 1,000 feet in the Los Angeles area, while over Hawaii it usually appears between 6,000 and 7,000 feet, if at all. Its height is fairly uniform over large distances parallel to the coast, but it seems to decrease in elevation very gradually northward, especially in late summer. Somewhere between Oakland, California and Portland, Oregon, the marine layer disappears, and the base of the inversion is at the surface from there northward. As far north as Tatoosh Island, latitude 48°, an inversion exists about 20 percent of the time in summer, but north of Tatoosh Island inversion conditions become increasingly rare. South of 30° latitude the inversion rises and weakens until finally it dissipates around 20° latitude in summer.

Figure 3 shows a series of lapse rate curves along a line perpendicular to the coast extending to sea southwest of San Diego. This illustrates the very typical progression from a low, strong inversion with low surface temperatures close inshore to higher and weaker inversions as the surface temperature increases southwestward. The cruise on which these data were taken continued along a direct line to within five degrees of the equator and then proceeded to Hawaii. Most of the remaining soundings show no inversions at all or weak, erratic inversions at heights of 5,000 to 7,000 feet. Unfortunately none of the cruises went north of 42° latitude; however, soundings at shore stations during strong high pressure situations illustrate the lowering and weakening of the inversion northward with the disappearance

[12] During the California Stratus Investigation of 1944, four-hourly radiosonde observations were taken at five stations in the southern California coastal area. Also, captive balloon soundings were taken from a ship off the coast, and airplane flights perpendicular to the coast were flown from various points to chart the height of the inversion from observations of the heights of the stratus cloud decks. These unpublished data are filed with the Meteorology Department, University of California at Los Angeles. Data from the two ships *Crest* and *Horizon*, operated by Scripps Institution of Oceanography, are also on file at U.C.L.A. and at the Office of Naval Research, Washington, D.C. Data for the first two years of operation, 1949 and 1950, have been published by the University of California under the heading, "Meteorological Observations from the Cruises of the *Crest* and the *Horizon*," *Technical Report No. 1, Subtropical Pacific Meteorology Project* (September 30, 1952).

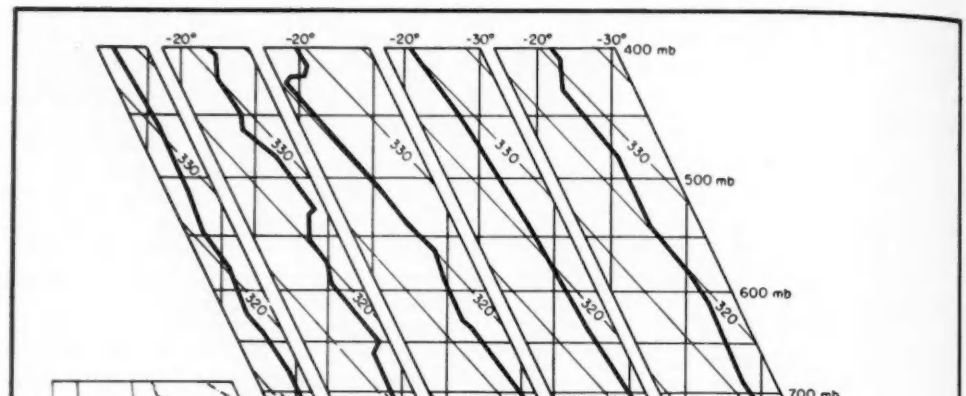

FIG. 3. Lapse Rate Curves Southwest of San Diego, California, July–August, 1950. All soundings taken from the *Horizon* at approximately 3 p.m. Greenwich Civil Time.

of the marine layer north of Oakland and the dissipation of the inversion north of Portland.

The inversion must be the result of the opposing processes of subsidence from above and convection and turbulence from below. Its intensity is determined by the temperature differential brought about by subsidence in the inversion layer and by contact with the surface in the marine layer. Hence, the inversion intensity in the air over the water is a function of total net subsidence of air in the inversion layer and of sea temperature. Where the air is moving over a colder surface with temperatures decreasing downstream, very little surface turbulence exists and subsidence extends to the surface. The total heating experienced by the subsiding air is large, and the inversion is intense with its base at the surface. Where the air is moving over a warmer surface with temperatures increasing downstream, surface turbulence and convection counteract subsidence to the extent that the inversion base is maintained above the surface and the inversion intensity is reduced because of a reduced total subsidence in the descending air.

Water effects are most noticeable, of course, where the differential heating of the air from below and above is greatest. Where the air passing over the water is actually warmer than the water and is cooled by it, the stabilizing effects of the water are paramount. But even where the air is slightly cooler than the water there still exists a differential in rates between the heating of the surface air from below and the heating of the above air by subsidence. A temperature inversion and stability are the consequences in either case. The surface air temperature remains a function of the water temperature whether it is above or below the temperature of the water. Surface heating

over the water in these areas is never commensurate in magnitude with the adiabatic heating produced by subsidence from above, as is the case over adjacent land areas at varying distances inland. The air circulating around the northeast side of the Pacific High in summer is warmer than the water until it reaches latitude 40° or 38°. In this northern area the inversion intensity is only moderate, and the inversion base is at the surface. But south of 38° convection due to surface heating begins and the marine layer appears by the time the air reaches the latitude of Oakland. As the air progresses southward along the coast it crosses continually warmer water, convection and turbulence lift the inversion, and the marine layer thickens. As soon as the base of the inversion is raised above the condensation level of the surface air, clouds form, and radiation from their tops insures the permanency of the inversion.

Although maximum stabilization is effected by the water when the water is colder than the air, the strongest inversion and the greatest aridity might not be attained here because atmospheric subsidence might not be at a maximum. It is the differential rate of heating between the surface and aloft that produces the temperature inversion, and the greatest difference may exist at some latitude intermediate between that where the air is being cooled by the underlying water and that where greatest atmospheric subsidence exists. During summer along the North American coast, the coldest water and the largest negative temperature anomalies exist in the San Francisco Bay region, but the strongest inversions exist farther south where atmospheric subsidence is more pronounced.

Local Controls of the Inversion

Near the coast, diurnal changes of height and intensity of the inversion are controlled by shore processes involving exchange of air between land and sea. In southern California the marine layer extends inland during the day as a sea breeze because of the differential heating between land and sea, and provides a cool surface layer, at the upper boundary of which a temperature inversion can be formed on contact with the warm subsiding air. Where the marine layer is absent over the land, the inversion is greatly reduced in intensity or is non-existent. The height of the inversion thus depends on the thickness of the marine layer.

The diurnal land-sea breeze regime may join with the mountain-valley breezes to produce a flow of marine air across the Los Angeles Basin to the surrounding mountains, sometimes extending inland to San Gorgonio Pass about 80 miles to the east.[13] Such a horizontal divergence of the marine air causes considerable vertical convergence since the mass of air affected does not extend far to sea. Hence, the inversion base along the coast is usually lowest in late afternoon or evening when the marine air has reached its greatest horizontal extent, and is highest early in the morning after the land breeze has concentrated the marine air near the coast. Since the height of the inversion is greatest early in the morning and lowest in the evening, it cannot be controlled by the daily regime of insolation. The height must be controlled by divergence and convergence in the marine layer and has definitely been correlated with temperature gradient inland.[14]

Leopold and Beer have shown that there is an excess of sea breeze over land breeze at lower levels along southern California.[15] This would produce a net horizontal divergence in the marine layer along the shore which would tend to maintain the inversion at a low elevation in spite of turbulence set up by warming from the water underneath. The fact that there is a greater net gain of southwest flow of air at Santa Ana than at San Clemente Island indicates that the seaward extent of the air involved in the daily regime is very limited, which probably accounts for the inversion being lowest in elevation only 10 miles or so offshore. The horizontal divergence in the marine layer is brought about by the land-sea contrast and occurs only along a narrow coastal strip.

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[13] For an excellent account of physical processes affecting the inversion in the California area see Morris Neiburger, C. G. P. Beer, and L. B. Leopold, *The California Stratus Investigation of 1944* (U.S. Dept. of Commerce, Weather Bureau, 1945), 83 pp.

[14] Dean Blake has shown good statistical inverse correlations between inversion base heights at San Diego and maximum temperatures at Mt. Wilson and Needles, California. (Cited in Morris Neiburger, "Temperature Changes During Formation and Dissipation of West Coast Stratus," *United States Weather Bureau Research Paper No. 19*, Dept. of Commerce, Washington, D.C., 1944.)

[15] Luna B. Leopold and Charles G. P. Beer, "The Coastal Sea Breeze in Relation to Diurnal Temperature Changes in the Lower Atmosphere," *Bulletin of the American Meteorological Society*, Vol. 28, No. 8 (1947).

Hence, a coastline paralleled by cool water embodies an added factor conducive to drought.

Atmospheric stability is directly affected by the control of surface temperatures by the cool sea and by the heating of the upper air by subsidence. Subsidence is dependent on the maintenance of high pressure over the area and is increased by the fact that the high pressure belts are broken into cells of circulation whose eastern termini approximately coincide with the western coasts, for maximum subsidence in a high pressure area occurs along its equatorward east side. The sea temperatures are maintained low for the latitudes by the general oceanic circulations, which bring water from higher latitudes, and by the process of upwelling of subsurface waters along coastal areas that are in active contact with the major oceanic and atmospheric circulations. If the major circulations did not parallel the coasts, surface contrasts between land and sea would be considerably reduced. On the other hand, it is apparent from the high degree of coincidence between the atmospheric circulations and the coasts that surface characteristics along these coasts exert some influence on the positions of the eastern termini of the subtropical high pressure cells. Increased surface temperature contrasts make for closer coincidence between subtropical anticyclonic circulation and the coast, and closer coincidence between circulation and coast enhances surface contrasts; so the two vary commensurately under mutual influence.

Some Preliminary Interpretation of Existing Phenomena

The rudimentary information just presented on physical processes active within the atmosphere and at the surface boundary allows for partial interpretation of precipitation distributions in these coastal areas with regard to the factors exercising ultimate control. The Australian west coast receives considerably more rainfall than any of the other four coastal areas under consideration; no point on the Australian coast records less than nine inches per year. Higher rainfall here corresponds with the fact that the Indian Ocean High is much less stable in extent and position than are the other oceanic highs. Often the Indian Ocean High is not terminated near the west coast but extends across Australia to the eastern mountains. At these times the coast is experiencing only the normal subsidence within the high pressure cell and not the added subsidence that is experienced along the eastern edges of high pressure cells. At other times, during the winter particularly, the subtropical high may split, and the west coast of Australia becomes a region of frontogenesis between an oceanic air mass and a modified mass of air over the continent. Besides these differences in the atmospheric conditions, there is no persistent oceanic movement along the shore, so that land-sea surface contrasts are minimized in the Australian area.

The lapse rates of temperature at Perth and Port Hedland (Fig. 4) reflect the reduced stability effected by normal subsidence and minimum surface contrasts in the Australian area as compared with the other areas. Here the lapse rates are generally steeper, inversions weaker, and surface temperatures considerably higher than along the other coasts. No extremely rapid rise in precipitation occurs on either side of the dry area since the coastline is relatively short in meridional extent and since surface contrasts are at a minimum all along it. There are no points at low and high latitudes where optimum surface contrasts are suddenly lost allowing for rapid increases in precipitation under conditions of weakened atmospheric subsidence. The precipitation increases gradually in both directions from a rather high minimum.

Aridity is most intense and the dry region most extensive along the coast of South America. Unfortunately no radiosonde data are available over the driest parts of the area,[16] but it may be assumed that the inversion is strong with its base near the surface throughout the region, because the sea is practically

[16] The only radiosonde observations available along the South American coast were taken during World War II at Salinas, Ecuador, and Seymour Island, Galapagos, both of which are too far north to truly depict air mass structure along the more arid parts of the coast. For these data respectively see Seymour L. Hess, "Some New Mean Meridional Cross Sections through the Atmosphere," *Journal of Meteorology*, Vol. 5, No. 6 (December, 1948), pp. 293–300, and Leo Alpert, "Notes on the Weather and Climate of Seymour Island, Galapagos Archipelago," *Bulletin, American Meteorological Society*, Vol. 27 (1946), p. 200.

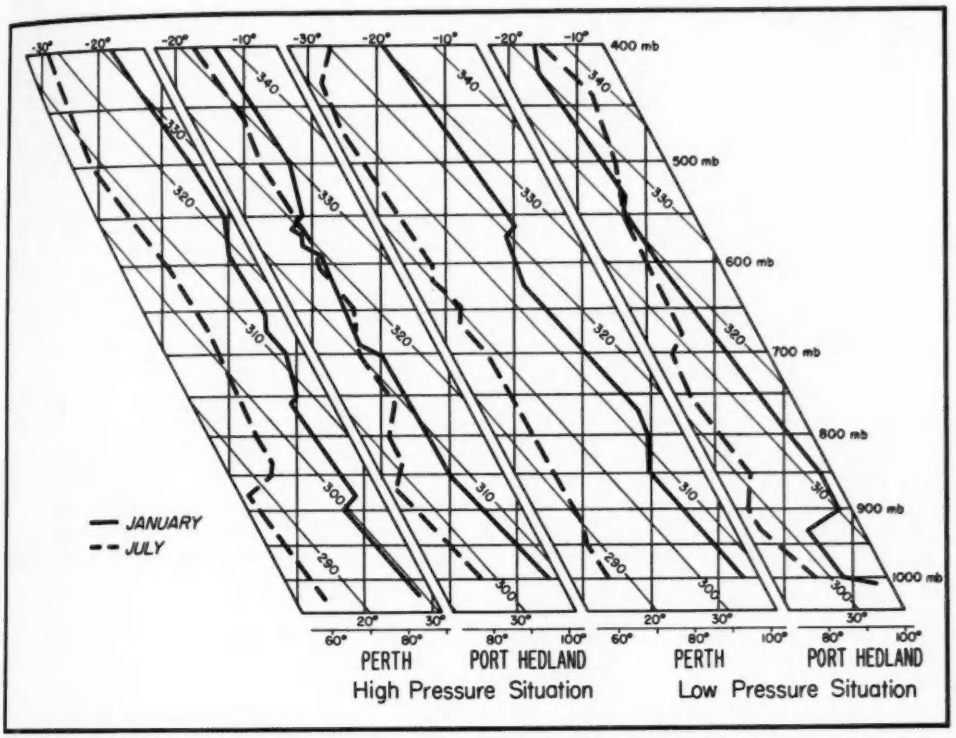

FIG. 4. Typical Lapse Rate Curves for Western Australia. Curves showing high pressure situations are for January 31, 1954, and July 19, 1953; those showing low pressure situations, for January 23, 1954, and July 10, 1953. Data from G. W. Mackey, Deputy Director, Meteorological Services, Perth, Western Australia.

always colder than the air to latitudes as low as 5°, and the coastal configuration is such that optimum contact is maintained with the major atmospheric and oceanic circulations all the way from Caldera to Cabo Blanco, a latitudinal distance of approximately 20°. The atmospheric stability that exists over the southwestern coast of Ecuador must be due almost entirely to the influences of surface contrasts, since an extremely rapid rise in precipitation totals takes place north of Cabo Blanco as soon as the major circulations diverge from the coast. A similar rapid rise in precipitation is experienced along the coast of northwest Africa south of Dakar, where the coastline and the major circulations diverge widely.

Radiosonde data taken at Walvis Bay and Rooikop in the heart of the driest area along southwest Africa (Fig. 5) show strong inversions, as might be expected from the coincidence of the eastern edge of anticyclonic atmospheric circulation with the coast and from the relatively cold water temperatures as compared with the air above. The aridity at Walvis Bay compares with that along South America, but this extreme aridity is not so extensive along the south African coast because the configuration of the coast is such that some loss of contact with the major circulations occurs around latitude 14°, north of Mossamedes. The rate of increase in precipitation equatorward is not precipitous, as it is in South America and northwest Africa, because some contact with the major circulations is maintained clear to the equator.

In northwest Africa, Casablanca, at about the same latitude as Long Beach, California, has much weaker temperature inversions than Long Beach, with the surface temperature usually as high as or higher than the maximum temperature in the inversion. This difference is no doubt due to the fact that the North Atlantic High and coldest waters along the coast of north Africa are shifted southward

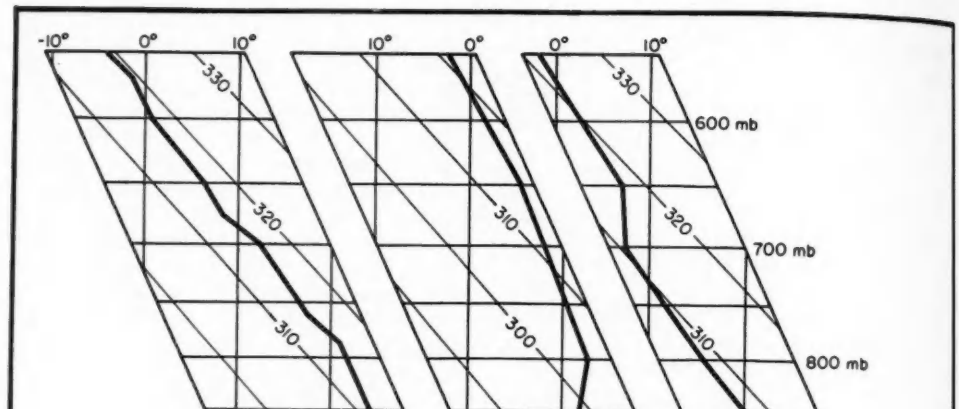

FIG. 5. Typical Lapse Rate Curves, Southwest Africa. Data from *Weather on the Coasts of Southern Africa.*

with respect to similar conditions along California. The water is usually colder than the air all along the coast, and the cold water extends to much lower latitudes than it does along North America. Dakar, at a latitude of less than 15°, receives an annual rainfall of only 18.6 inches, whereas on the North American coast similar latitudes receive 40 to 50 inches. Distributions of temperature in the vertical at Dakar show occurrences of inversions during all seasons, with particularly strong and persistent inversions in late winter and spring. This is far south of any inversion occurrence for North America. Radiosonde data from Casablanca and Funchal, Madeira Islands, combined with inversion data previously collected from the German ship *Meteor*,[17] show a lifting and weakening of the inversion from the coast out to sea reminiscent of the California area.

Maximum inversion intensities occur much farther poleward along North America than along the other coasts because minimum water temperatures occur much farther poleward. Along north and south Africa and South America, as far as can be determined, greatest inversion intensities occur in approximately the same regions as greatest aridity. In North America the greatest inversions in summer exist 8° to 12° of latitude north of the driest coastal area. It appears, then, that in North America the region of coldest water and the region of maximum atmospheric subsidence are not so nearly coincident as they are in the other continents. This poleward position of the cold water probably accounts for the greater annual precipitation in the drier coastal

[17] H. von Ficker, "Die Passatinversion," *Veroff. d. Met. Inst., University of Berlin*, Bd. I, Heft. 4 (1937). Maps from this study showing inversion characteristics in the Atlantic Ocean area are included in Herbert Riehl, *Tropical Meteorology* (New York, 1954).

areas of North America than in Africa and South America and the reduced summer rainfall at higher latitudes in North America as compared to South America.

COMPARATIVE ANALYSIS

The most success that could be hoped for in an investigation of this sort would be to break out of the circular reasoning of atmospheric circulation, surface temperatures, atmospheric circulation—and to solve the basic question of what is the original cause of what. This paper does not pretend to accomplish that ultimate goal. But it can be said that since the subtropical high pressure areas are broken into separate cells whose mean eastern boundaries of circulation are usually approximately coincident with the respective coastlines, and since the greatest surface divergence takes place on the equatorward part of the eastern arc of an anticyclone, then the optimum combinations of atmospheric subsidence and surface contrasts do exist along subtropical coasts on east sides of ocean basins. If the coasts were not present the surface contrasts would not exist and the atmospheric circulations might be quite different. Such coastlines, then, are climatic controls conductive to aridity. Some quantitative measure of the relative effects of the aridifying factors upon total precipitation amounts along these coasts can perhaps be arrived at by the method described in the following pages without determining cause-and-effect relationships among the factors themselves.

Factors controlling atmospheric stability and precipitation amounts along these coasts might be listed as follows: (1) control of surface air temperatures by a cool sea, (2) normal subsidence in a subtropical anticyclone, (3) additional subsidence along a coastline where the subtropical high has been severed and the eastern terminus of the anticyclonic circulation coincides with the coast, where cool surface temperatures have allowed for vertical shrinkage in the lower atmosphere, and where a sea-breeze regime has produced horizontal divergence in the surface air stratum, and (4) local effects.

Local effects are largely incorporated in the other three factors—projections of the coastline which cause local increases and decreases in upwelling, sheltered inlets protected from contact with open-ocean circulation, terrain features which cause local perturbations in the air flow. All these produce local variations which often inexplicably complicate the climate of a given area. Their presence must be acknowledged in any complete analysis of a given area, but their effects must be largely eliminated in a study of continental comparisons.

Normal subsidence is that which takes place within a high pressure area due to convergence aloft and general settling throughout the air mass. It is usually a passive sort of movement depending for continuance on horizontal divergence below, and produces stability near the ground only after an extended accumulation of effect. To this must be added the "coastwise" subsidence which occurs along cool-water coasts, as stated in point "3" above. It will be difficult to distinguish between normal subsidence and coastwise subsidence because the results are similar, but as indicated by various radiosonde observations, when coastwise subsidence is present it is usually the more active of the two and produces lower, stronger inversions than normal subsidence does, with steeper lapse rates above the inversions. It can be assumed that normal subsidence is acting alone when high pressure extends unbroken across the coast. Coastwise subsidence, of course, is dependent for existence on land-sea contrasts; its effects will be difficult to separate from other effects of the surface contrasts because they will occur simultaneously and in proportionate magnitudes.

Although the climatic controls are interdependent to a high degree, an attempt will be made to distinguish between them as much as possible by comparing precipitation amounts in the coastal areas and interpreting their variations as far as possible in the light of the physical relationships just discussed. If a quantitative analysis is to be attempted, precipitation amounts must be plotted in some form to allow for accurate comparisons. No graph has the advantage of inherently depicting any significant relations between precipitation and some controlling factor. For simplicity of form of the resultant curves and for ease of relating points plotted to actual locations along the coasts, precipitation amounts have been plotted against latitude in Figure 6. By drawing smooth curves local variations have been essentially eliminated.

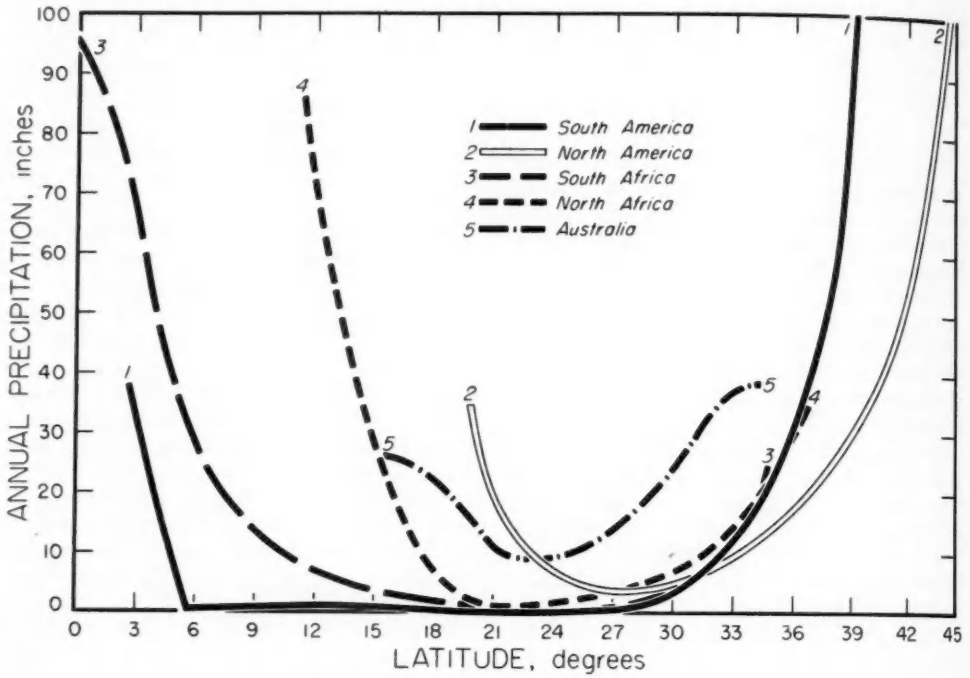

FIG. 6. Annual Precipitation–Latitude Curves.

South America and Australia represent the two extremes; South America with upper air and surface stabilizing factors at an optimum, Australia with surface factors at a minimum. Conditions along the coasts of North America and Africa lie somewhere between these two extremes. The best standard available for basing conclusions as to relative magnitudes of precipitation controls along all the coasts is the precipitation condition for Australia. Perhaps stabilizing processes at the surface are not completely inoperative, or perhaps normal subsidence is not at an optimum in the Australian area, but certainly these two criteria are approximated along the western coast of Australia, and a comparison of precipitation amounts along the other coasts with those along the coast of Australia will provide a basis for interpreting the types and magnitudes of the aridifying controls in each area.

Comparisons of Annual Precipitation Totals

Maximum normal subsidence, corresponding to minimum precipitation for Australia, seems to occur around 23° latitude in the Southern Hemisphere. This agrees as well as can be determined with the average annual position of the equatorward-east side of the subtropical high in each ocean. Latitudinal positions in south Africa agree almost perfectly, Walvis Bay at 22°55'S having the lowest recorded rainfall on the coast. The nine inches, or so, difference between minimum rainfall in Australia as against South America and southwest Africa must be accounted for by the influences of surface contrasts, as must be the prolongation of the dry coastal strips in South America and Africa. Since surface contrasts maintain precipitation amounts at practically nil to very low latitudes in South America, it is evident that either the surface contrasts could have achieved absolute dryness around Iquique and Antofagasta alone without normal subsidence, or that the influences of surface contrasts increase equatorward.

The point of minimum precipitation in North America is shifted about five degrees poleward compared to those in the Southern Hemisphere. Most of this shift is no doubt due to the northward average position of the heat equator with the attendant poleward shift of the North Pacific High. Surface contrasts have some in-

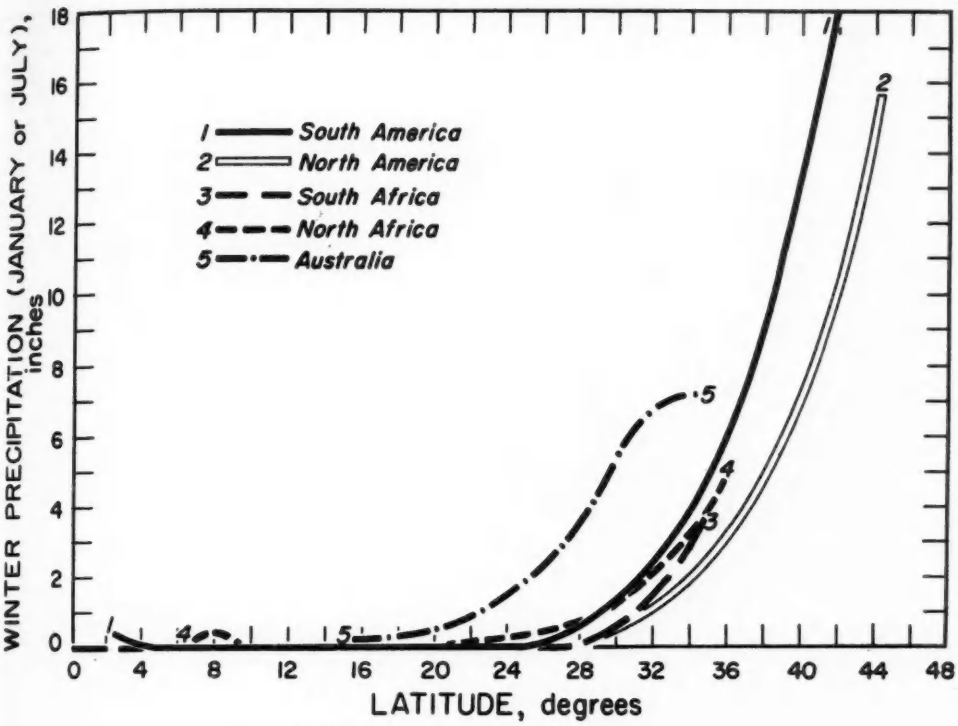

FIG. 7. Winter Precipitation–Latitude Curves.

fluence at this latitude, for minimum rainfall is well below the nine-inch standard set by Australia. But they are not as marked as in South America or south Africa, for minimum water temperatures are not found here; they occur much farther north, where upwelling brought about by optimum contact with the open-ocean circulation is most active. The coastal configuration of North America is such that divergence from the open-ocean circulation occurs at a relatively high latitude.

Northwest Africa does not diverge from the open-ocean circulation so quickly, so that surface contrasts are maintained at a significant level to Port Étienne, where apparently maximum atmospheric subsidence is reached. Thus, Port Étienne compares in dryness to South America and southwest Africa, but this dryness is no sooner reached than it is lost south of Port Étienne as the coast turns abruptly and diverges from the general circulation. The curves for North America and northwest Africa are much the same except for a latitudinal shift of about four degrees and differences in rainfall amounts of from three to five inches. North Africa is drier because maximum subsidence and maximum surface contrasts more nearly coincide. The average summer position of the North Atlantic High is about six degrees latitude farther south than that of the North Pacific High. Maximum temperature contrasts occur much farther equatorward in north Africa because the shape of the continent is such that the open-ocean circulation does not really impinge against the shore until about latitude 30°.

Seasonal Comparisons

The precipitation-latitude curves for all coasts are strikingly similar in winter (Fig. 7), except for a few latitude shifts of from four to eight degrees. The fact that all coasts remain dry to very low latitudes in winter signifies the greater influences of surface contrasts at low latitudes. It is doubtful that maximum subsidence prevails over a latitudinal distance of 20° or more; certainly it does not during the summer when the oceanic highs have sup-

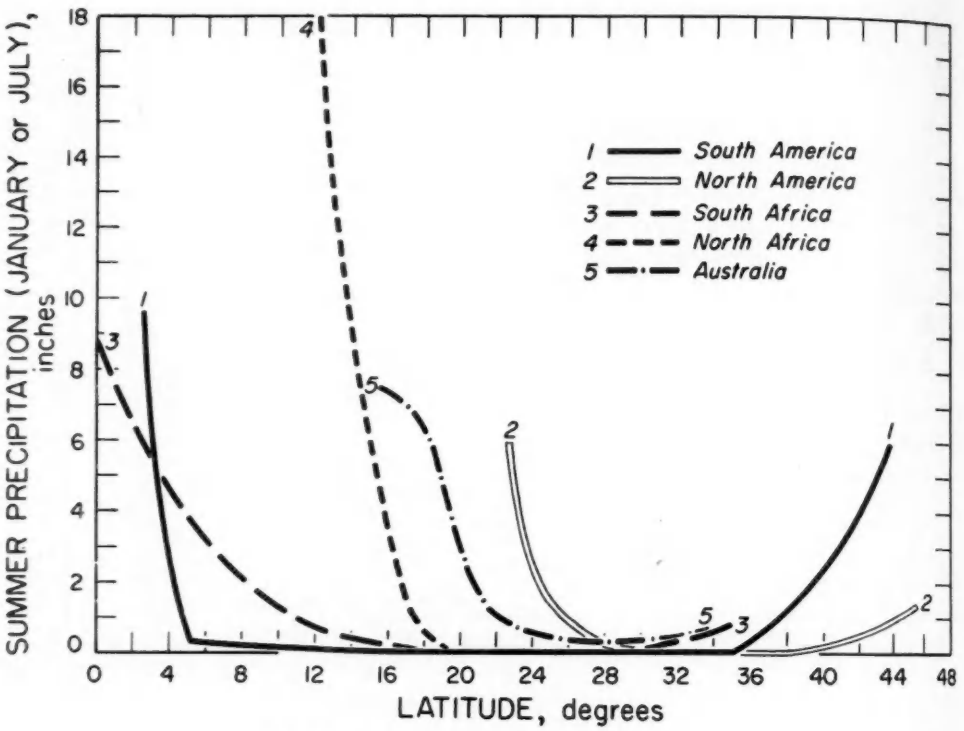

FIG. 8. Summer Precipitation–Latitude Curves.

posedly reached their greatest development. Therefore, drought to very low latitudes in winter must be due to surface contrasts, an accomplishment which is apparently impossible to attain at higher latitudes during the summer (Fig. 8).

The differences already observed on the annual rainfall-latitude graphs are almost entirely a result of summer differences. On the summer curves it is readily seen that the rapid increases of precipitation equatorward in North America and northwest Africa take place where coastlines diverge abruptly from the open-ocean circulations. These limbs of the curves are very similar in slope to that for Australia where it has been assumed that little surface influence exists. It might be assumed, then, that the equatorward limbs of the curves for North America and northwest Africa represent the curve of latitudinal increase of precipitation due to decrease of normal subsidence with an absence of surface contrasts. South Africa loses some contact with the open-ocean circulation north of Cape Frio, but some surface contrasts remain to diminish precipitation clear to the equator. The coastal configuration of South America is such that active contact with the open-ocean circulation is maintained in spite of the diminished strength and increased westerly set of the circulation equatorward.

The poleward limbs of the curves are represented only for North and South America without undue extrapolation. The greater flattening of the North American curve clearly shows the effects of the poleward shift of maximum temperature contrasts. But it appears that surface contrasts at this high latitude are less effective than at low latitudes, for they are unable to maintain absolute dryness against the waning effects of subsidence.

SUMMARY

The annual precipitation-latitude curves indicate that normal subsidence at an optimum can reduce precipitation to about nine inches over a latitudinal distance of one or two degrees and will allow a precipitation increase at the rate of approximately four inches per

FIG. 9. Location Map. Locations of all reporting stations used and all places mentioned in the text.

degree in either direction. The additive effects of surface contrasts can reduce precipitation to zero at the point of maximum subsidence and can hold it at that level against the waning effects of subsidence to low latitudes[18] so long

[18] In this discussion, low latitudes are defined as less than 20°, intermediate latitudes as 20° to 30°, and higher latitudes as over 30°.

as active contact with the open-ocean circulation is maintained. Where surface contrasts are maintained at an optimum to higher latitudes, their effects can reduce precipitation by three-fourths or more but cannot hold it at zero. Under ideal conditions, then, the absolute aridifying effects of surface contrasts are greatest at low latitudes and decrease poleward; the relative effects, compared to normal subsidence, are greatest at low latitudes and least at intermediate latitudes, with a slight increase at higher latitudes. Surface contrasts are most important in summer, since few differences among continents appear on the winter precipitation-latitude graphs.

Along North America in summer, maximum surface contrasts occur at about 40° latitude. The North Pacific High is centered near 42°, and maximum normal subsidence occurs on the equatorward-east edge at about 35°. The combined effects of subsidence and surface contrasts hold summer precipitation to zero from 30° to 38°. North of 38° maximum surface contrasts cannot maintain absolute dryness against the waning effects of subsidence, and some summer precipitation occurs. South of 30° surface contrasts rapidly disappear, allowing a rise in convective precipitation commensurate with the decrease of normal subsidence equatorward.

The South Pacific High is centered at about 37°, maximum normal subsidence occurring probably around 30°. Surface contrasts are great along South America all the way from 36° to 5°. The combined effects hold precipitation to zero most of this distance during the summer, with surface contrasts becoming more significant the farther equatorward one proceeds. At the equatorward extreme the drought must be due entirely to surface contrasts, since a rapid rise in precipitation is experienced north of Cabo Blanco as soon as surface contrasts are lost.

The North Atlantic High in summer is centered at approximately 36°N so that maximum normal subsidence along northwest Africa is shifted five or six degrees equatorward with respect to that for North America. Also, the coastal configuration of northwest Africa is such that the open-ocean circulation does not actively impinge upon the shore until about latitude 30°. Therefore, maximum normal subsidence and maximum surface contrasts nearly coincide around 28°, and absolute aridity is maintained from 20° northward. South of Dakar a tremendously rapid increase in rainfall parallels the case for South America in the Gulf of Guayaquil, indicating that the effects of normal subsidence are essentially nil at this latitude, and a rapid rise in precipitation results as soon as the coast diverges from the open-ocean circulation.

The South Atlantic High is centered at about 32°S allowing for maximum normal subsidence around 25°. Surface contrasts combine with this to produce absolute aridity to 20°. North of Cape Frio the coast loses a good deal of contact with the open-ocean circulation, and precipitation increases. However, it does not increase so rapidly as it does south of Dakar in northwest Africa. The difference between the equatorward limbs of the north and south African precipitation curves might be assumed to be the result of some surface contrasts which exist all along the southwest African coast clear to the equator.

The winter precipitation-latitude curves for North and South America and Africa are very similar. Surface contrasts combined with normal subsidence from the weakened oceanic highs are apparently strong enough to produce near-absolute aridity equatorward of 26°. Poleward from 26°, the effects of surface contrasts are nil, and precipitation increases with latitude as stormy weather prevails.

THE POLITICAL GEOGRAPHY OF THE GULF OF AQABA[1]

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TWO arms of the Red Sea, the Gulf of Suez and the Gulf of Aqaba, stretch towards the Mediterranean. The Gulf of Suez has many reefs and islands; sudden squalls and contrary winds make its narrow passages dangerous. Until the advent of steam propulsion this Gulf was therefore not much used for navigation. Traffic to and from the Mediterranean moved up the Nile to a point below the first cataract, and from there to ports on the Red Sea, e.g., Qena-Safaga, by an overland route not much longer nor more difficult than the crossing of the isthmus of Suez. There is some evidence that the ancient Egyptians built a fresh water canal from the Nile Delta to the Red Sea, but its use for navigation has not been established. Regular traffic across the isthmus and in the Gulf commenced in 1837, as soon as steamships began to travel in the Red Sea and a mail-coach service was established. Twenty years later the coach service was replaced by a railroad, and in 1869 the Suez Canal was opened. The isthmus of Suez has little relief, and there are no locks or tunnels on this international waterway.

The Gulf of Aqaba is about a hundred miles long and an average of fifteen miles wide. It has many reefs and islands, particularly at its mouth; sailing there is at least as difficult as on the Gulf of Suez. It is enclosed by faulted steep slopes which rise rapidly to elevations exceeding two thousand feet. Only a few rugged wadis break up these slopes and there is no continuous foreland. The only trail following the eastern side of the Gulf between Aqaba and Haqal had to be hewn out of the rocks of the slope; the western side is in general equally forbidding and no trail follows this shore. However, from the about four-mile-wide head of the gulf the ground rises very gradually towards the divide (el. 700 feet) with the Wadi Araba that drains to the Dead Sea. North of this divide the passage to the Mediterranean is easier than a direct passage from the Gulf, although the routes involve climbing to about two thousand feet over frequently steep and rugged terrain. Altogether the shortest practicable overland route from the Gulf of Aqaba to the Mediterranean near Gaza involves a difficult journey of about two hundred miles compared with the easy hundred mile trip on the Suez Canal.

In comparison with Egypt the natural endowment of the region, draining in many wadis to the Gulf of Aqaba, is scanty. While there is as much rainfall as in southern Egypt—available observations indicate a winter rainfall of less than three inches per year at the head of the Gulf and up to eight inches on the higher mountains—there are no rivers or wadis holding sufficient water to provide for irrigation. Wells are few and far between—most contain brackish water. Because of the heat throughout nearly the whole year grazing is also very limited (Fig. 1). Disregarding military garrisons and refugees from Israel (now residing in Jordan) the total population of the region cannot exceed three or four thousand. Most of the original inhabitants are nomadic Bedouins, members of tribes issuing primarily from the central Sinai peninsula. The town of Aqaba, which contains the only good wells of the region and thus the best date gardens, had about four hundred permanent residents together with about six hundred migratory inhabitants before the influx of the refugees. Yet despite the relatively difficult land route from the Mediterranean and the scanty local endowment, immigrants or governments established in the north have frequently attempted to occupy the region to develop trade with the East. These attempts can be traced in the patterns of the political geography and the resulting economic development.

EARLY PATTERNS

The first attempt at trade (about 1000 B.C.) is recorded in the Book of Kings:

[1] This study is the outgrowth of field work in the Middle East during the summers of 1953 and 1954 supported by a grant from the New School for Social Research. I was assisted by information from British, Israeli, and Jordanian government departments and United Nations agencies. Responsibility for the evaluation of the material and the conclusions rests entirely with me.

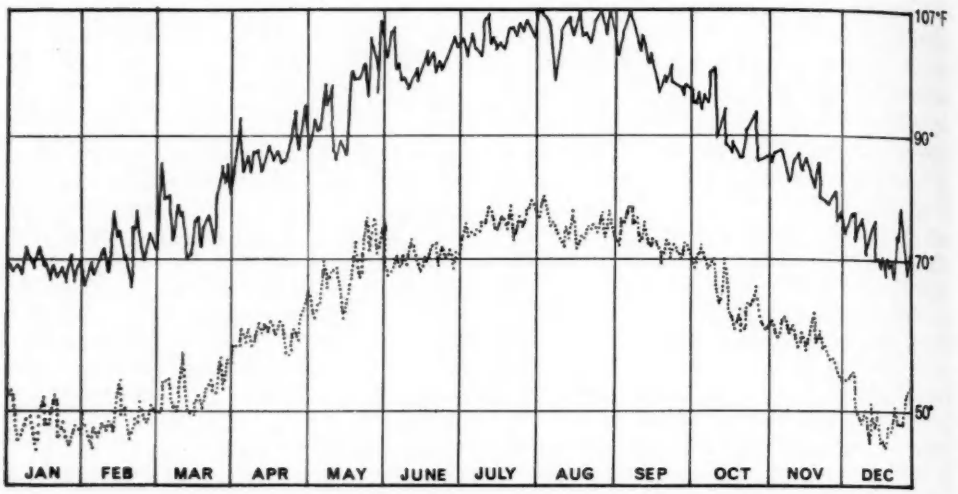

FIG. 1. Daily maximum and minimum temperatures at Aqaba (average 1943–47). According to D. Ashbel, *Bio-Climatic Atlas of Israel* (Jerusalem 1952), p. 110.

> "King Solomon made a navy of ships in Ezion-geber, which is beside Eloth . . . in the land of Edom.
> And Hiram sent in the navy his servants, shipmen that had knowledge of the sea, with the servants of Solomon.
> And they came to Ophir, and fetched from thence gold, four hundred and twenty talents, and brought it to King Solomon."[2]

Professor Glueck, who excavated a site four miles west of the town of Aqaba and about five hundred yards inland, believes that he has found the port referred to in the Bible.[3] Due to the rate of sedimentation in the Gulf an advance of the shoreline of this magnitude is not impossible. The archeological evidence indicates that the port was used only for a short period, which accords with another biblical reference. Probably only a few journeys took place, and a later attempt to reoccupy the area referred to in the Bible did not result in any trade. With reference to these journeys Hornell states that "rumour vastly exaggerated their quantity and value."[4] Further, Wissmann believes that the introduction of the camel into Western Asia about this time resulted in "a busy traffic of camel caravans . . . in competition with traffic by sea."[5] This may also account for the limited use of the Gulf of Aqaba.

The Romans occupied the region about one thousand years later. Although they built a road to the Gulf there is no record of any trade. This appears reasonable, as the Romans had use of the Nile for transportation of imports from the East. During the first centuries A.D. the region was probably a part of the Nabatean Kingdom, whose capital and *oicoumene* were located to the north at Petra (now in Jordan) and near Abde and El Auja (now in Israel). The wealth of this Kingdom was built upon cereal cultivation in wadis draining toward the Dead Sea or the Mediterranean and possibly trade with Arabia; there is no evidence of shipments through the Gulf.

THE CRUSADERS

Much more detailed information is available about the activities of the Crusaders.[6] In 1115 King Baldwin of Jerusalem, after a seven-

[2] Authorized King James Version, I Kings, chap. 9, v. 26, 27, 28.

[3] Nelson Glueck, "The Topography of Ezion-Geber and Elath," *Bulletin of the American School of Oriental Research*, No. 72 (December 1938), pp. 2–13.

[4] James Hornell, "Naval Activity in the Days of Solomon and Rameses III," *Antiquity*, No. 82 (London, June 1947), p. 71.

[5] Hermann von Wissmann, "On the Role of Nature and Man in Changing the Face of the Dry Belt of Asia," *Man's Role in Changing the Face of the Earth*, William L. Thomas, Jr., ed. (Chicago, 1956), p. 296.

[6] Summarized from Steven Runciman, *A History of the Crusades*, Vol. II (London, 1952); and Ph. Scherti, "Ela-Akaba," *Orientala Christiana Periodica*, Vol. II (Rome, 1936), pp. 34–77.

FIG. 2. Approximate frontiers of the Kingdom of Jerusalem circa 1165 A.D. According to Stephen Runciman, *A History of the Crusades*, Vol. II (London, 1952), p. 145.

day ride from his capital, occupied the site of the present town of Aqaba with a force of two hundred men. A fort and bishopric were established, and Aqaba became part of the seigneurie of Montreal, which also included most of the permanently inhabited parts of the pre-1947 area of Trans-Jordan. To control the Gulf the Crusaders established themselves simultaneously on the waterless islet of Gezira Firoun, which they called Isle de Graye, about twelve miles southwest of Aqaba. To this day the Isle de Graye is the only place in the head of the Gulf which can shelter ships from the heavy winter gales that can cause waves up to seven feet high. The significance of the island is shown by the fact that, when it was captured by Moslems in 1170, the Crusaders immediately withdrew from Aqaba. Twelve years later, in 1182, when the Crusaders failed in an attempt to recapture the island, they also abandoned all plans to hold Aqaba. During their long occupancy of both Aqaba and Isle de Graye the Crusaders, except for one daring raid of the ports serving Medina and Mecca and a Sudanese port, never succeeded in developing trade through Aqaba. The Kingdom of Jerusalem, for lack of eastern transit trade by this or any other route, remained poor. It succumbed to Moslem attack (1189) sooner than the northern crusader states, which had become wealthy from participation in trade along the fertile crescent, and thus survived another century. The only product exported from Aqaba was local seashells which were greatly admired in the western world.

TURKEY

After the withdrawal of the Crusaders the region remained untouched by world affairs for seven centuries. When a Frenchman visited the area in the early nineteenth century, he found no ships in the Gulf.[7] To reach Isle de Graye he—like Lawrence of Arabia[8] in 1914—

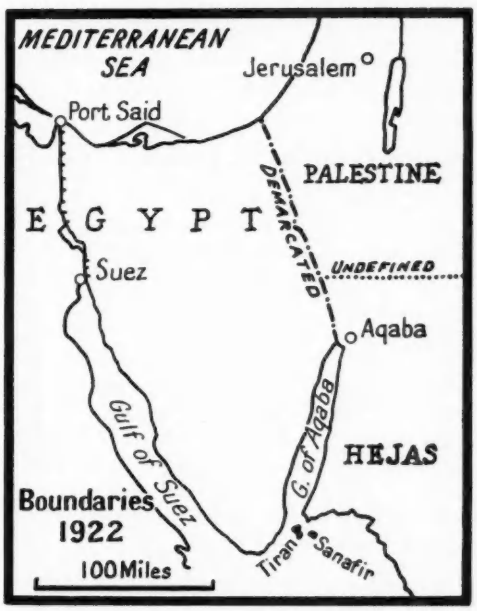

FIG. 3. Status of Boundaries in 1922.

[7] Baron Jean de Laborde, *Journey through Arabia Petraea to Mount Sinai* (London, 1836), p. 92. Laborde reports that Isle de Graye had a circumference of 1,650 yards.

[8] C. Leonard Woolley and T. E. Lawrence, *The Wilderness of Zin* (London, 1936). Lawrence criticizes the measurements of Laborde and reports that Isle de Graye consists of two sharp points of rock, each about 50 feet high, connected by a low sandbank. Recent local reports are also contradictory; probably the sandbank alters its shape. G. W. Murray, "The Land of Sinai," *Geographical Journal*, Vol. CXIX, part 2 (June 1953), p. 154, mentions the use of the raft by Lawrence.

had to build his own raft out of local brushwood and palm-trunks. Finding no signs of recent visitors he claimed Isle de Graye for France on the basis of previous occupation by French Crusaders. On account of unimportance of the Gulf this claim lapsed. Ibrahim Pasha of Egypt occupied Aqaba in 1840. He built a road across Sinai peninsula to the town to facilitate pilgrim traffic from the Nile to Mecca as well as for strategic reasons. After the British occupation of Egypt, Turkish troops installed themselves in Aqaba without opposition in 1892. In the early years of this century they commenced to advance down the western side of the Gulf. Great Britain protested against this move. To avoid any serious disputes a boundary between then British occupied Egypt and Turkey was agreed upon in 1906 and demarcated across Sinai peninsula. In return for cession of an area north of Wadi el Arish in northeastern Sinai peninsula, which had been included vaguely in Turkish administrative districts of Southern Palestine, Turkey obtained Aqaba together with the head of the Gulf, although not Isle de Graye. This boundary persists to this day in the armistice line between Egypt and Israel, except for changes near the Mediterranean. Turkey planned to build a spur from the then projected Hejas Railroad to Aqaba and to develop the port for trade with the East. However, apart from the construction of a telegraph line to Aqaba, nothing was done, and when the British occupied the town in 1917 there was not a single fishing boat in the region.

JORDAN (FORMERLY TRANSJORDAN)

At the conclusion of World War I the Turkish portion of the Gulf up to the Egyptian boundary became part of the Kingdom of Hejas,

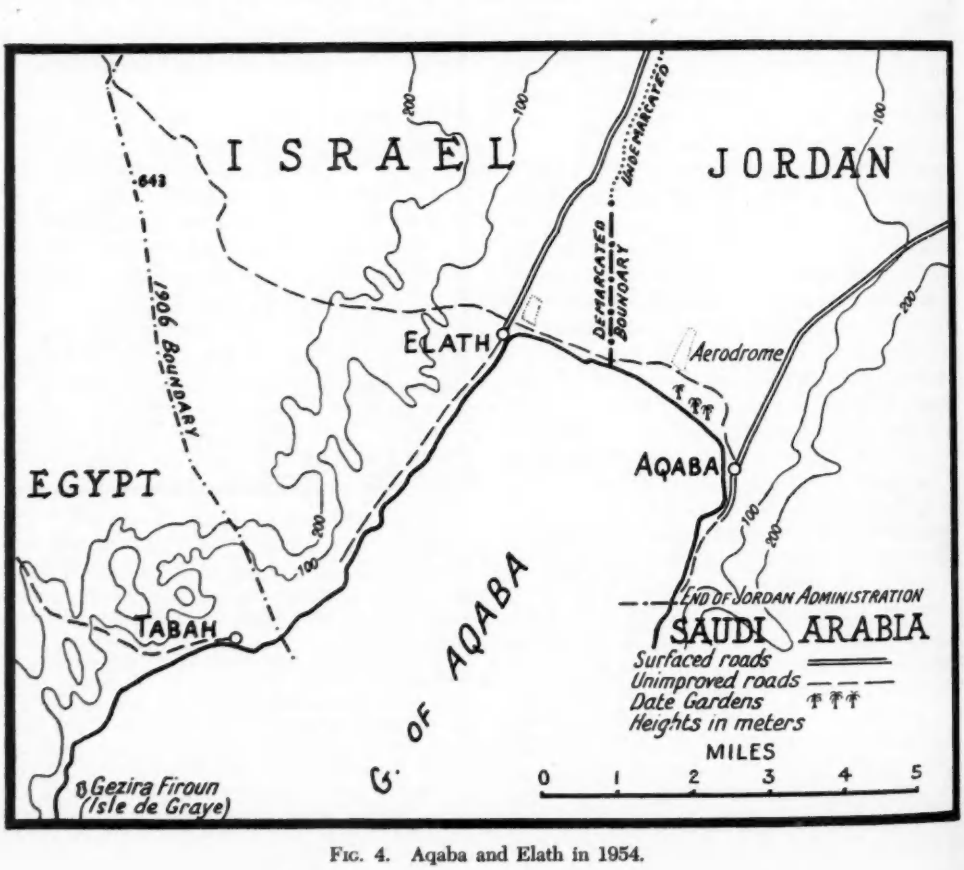

FIG. 4. Aqaba and Elath in 1954.

then closely allied to Great Britain. When Ibn Saud, as Sultan of Nejd, conquered the Hejas a few years later, Great Britain insisted on cession of the area at the head of the Gulf to Palestine and Transjordan. However, a peace treaty in 1927 between Great Britain and Ibn Saud's state, later called Saudi Arabia, did not define a boundary near the Gulf. Soon a *de facto* boundary developed at points where Transjordan administration ceased. This boundary, which has never been demarcated, persists today, and runs inland in a straight line from a point about two miles south of Aqaba. All flat land suitable for port or city development was included within Transjordan. To express Saudi Arabian protests against this boundary no traffic to or from Aqaba is permitted to cross this line. Several journalists have stated that Great Britain insisted on cession of this area in view of her conflicts with Egyptian nationalism to enable her to construct an alternative to the Suez Canal from Gaza to Aqaba.[9] No survey for such a canal ever has been made, and indeed the construction of a seaway of this nature has to be relegated to the realm of phantasy.

No boundary was demarcated between the British mandates of Palestine and Transjordan, except for a few points close to the Gulf which were determined in 1946 prior to the Arab-Israeli war. Today's armistice boundaries between Israel and Jordan generally follow the line of least elevation in the wadis south of the Dead Sea and are correspondingly vague. Altogether Jordan always had only about five miles of shore line on the Gulf between boundaries that are now closed to traffic. Despite this narrow shore front, Transjordan engineer regiments built a road from Maan to Aqaba entirely within Transjordan territory during the Palestine disorders in the late nineteen-thirties. This road was planned to serve Transjordan and its British garrison in case of a stoppage of traffic through Haifa, its regular supply port. In 1941, when German armies were threatening Egypt and British control of the Eastern Mediterranean, the rapid construction of a railroad from Maan to Aqaba was commenced with rails and ties from the derelict Hejas railroad south of Maan. This railroad was to supply British armies in the Levant in case traffic through Egypt was no longer possible. On account of the British victory at El Alamein the railroad was never completed beyond Ras en Nabk.

TABLE 1.—PORT OF AQABA: CARGO TRAFFIC[1]
(in metric tons)

Year	Number of ships	Imports	Exports		Total cargo traffic
			Phosphate	Other	
1952	Particulars not available				ab. 50.850
1953	122	67.665	3.200	829	71.694
1954	173	80.012	11.055	1.284	92.351
1955	222	134.626	65.350	900	200.877

[1] Source: Communication from the President, Aqaba Port Authority, Amman, Jordan.

As a result of the Arab-Israeli war and the boycott of Israel by the Arab states, Jordan (name changed from Transjordan in 1948) no longer uses Haifa. Since transportation through Beyrouth is very expensive, Jordan began to utilize Aqaba in 1952 (Table 1).[10] Ships anchoring about five hundred yards offshore are discharged into lighters that unload their cargo in a lighter basin or at a wharf built during World War II. Transit sheds for general cargo, sugar, and flour, as well as a thousand-ton tank storage farm for gasoline and diesel-oil have been provided. Arab refugees from Israel, who have increased Aqaba's population to about four thousand inhabitants, include experienced stevedores from Haifa and Jaffa. With the use of several mobile cranes eight hundred and fifty to one thousand two hundred tons of cargo per day can be handled regularly. Main imports are foodstuffs, including sugar, also lumber, petroleum products, steel, machinery, vehicles, and textiles. In years when the winter rains in Jordan have been unsatisfactory, wheat and flour are also imported to remedy the local grain deficit. Phosphate rock containing 72 to 74 percent of phosphate of lime from a quarry at Roseifa north of Amman is exported in bags. In addition to charter vessels, several British lines con-

[9] E. G. Wolfgang von Weisl, *Zwischen dem Teufel und dem Roten Meer* (Berlin, 1928); the canal is also mentioned without detailed reference by Norman Bentwich, "Developments in the Negev," *Journal of the Royal Asian Society*, Vol. 42 (April 1955), p. 183.

[10] Statistical and port information on Aqaba from United Nations (Technical and Economic Assistance) and Aqaba Port Authority. The British army in Jordan occasionally utilized Aqaba after World War II.

nect Aqaba with British and Belgian ports, sailing about twice a month. A monthly German service connects Aqaba with ports of the Hamburg-Le Havre range, also calling at Marseilles and Naples. Since 1955 an American line calls at Aqaba monthly on journeys to and from U.S. Gulf and Atlantic ports. A Jordanian decree effective May 1, 1956, provides that all Jordanian imports from Eastern Europe and West Germany have to be made via Aqaba.

The same shipping lines connect Aqaba with Eastern ports; except for phosphates (shipped mainly by charter vessels to India and Japan) traffic in this direction is not significant. Special charter vessels transport pilgrims to Jedda for Mecca and Medina. In 1955 the number of pilgrims travelling by this route exceeded ten thousand. Fishing has been developed, and a processing plant produces about three hundred tons of preserved fish per year.

Construction of deep-water wharves for the direct handling of ocean-going vessels is now planned on a site south of the village of Aqaba and close to the Saudi Arabian frontier. These facilities, planned by United Nations experts, are expected to be ready in 1958 and will permit the bulk handling of the growing phosphate export. The construction next to the new wharves of a new quarantine station to handle the pilgrim traffic is also envisaged.

Cargo moves by truck between Aqaba and the rail-terminal at Ras en Nabk. From there most traffic moves by rail to destinations in northern Jordan; a part continues by truck to the Jordanian sector of Palestine which has no railroad connections. No extension of the railroad from Ras en Nabk to Aqaba is now planned, since this would involve a very steep descent of over five thousand feet which can be handled more economically by trucks along a fifty-two mile long highway.[11] Costs of transportation from Aqaba to Amman and northern and western Jordan, where nearly the whole population of the state is concentrated, average about thirty dollars per ton compared with about thirty-nine dollars from Beyrouth, and a theoretical cost of less than ten dollars from Haifa. Ocean freight rates quoted by the various lines serving Aqaba are about equal to or slightly higher than rates to Beyrouth or Haifa. In view of this transportation cost pattern the government of Jordan hopes to save about ten percent of the country's foreign exchange disbursements by diverting a large part of its maritime traffic to Aqaba. Available information on costs also indicates that transportation through Aqaba will cease to be economical as soon as movements through Haifa again become possible. Commodities which will probably continue to be shipped via Aqaba are bulky materials required for consumption in southern Jordan, exports of phosphates from an undeveloped low-grade deposit at El-Hassa about one hundred and forty miles from the Gulf, and possibly other minerals (copper and manganese) expected to be discovered in commercial quantities in southern Jordan. The import of petroleum products through Aqaba will decline substantially as soon as a refinery processing crude oil obtained from the Trans-Arabian pipeline, which crosses northern Jordan, commences production.

[11] Two flights per week connect Aqaba and Amman. Passengers and small amounts of cargo (e.g., fresh fish) are carried.

ISRAEL

In March 1949 Israeli troops reached the shore line of the former Mandate of Palestine in the Gulf. Subsequent armistice agreements confirmed Israeli occupation and gave the new state about nine miles of coast line. Near Umm Rashrah, a former Palestine police station and not far from the ruins of Ezion-Geber, the village of Elath (sometimes spelled Eilat) was established. Israel planned to develop Elath into an ocean port and build a short pier suitable for the discharge of lighters or vessels up to two thousand tons. In 1954 the village had a population of about six hundred inhabitants.

Until November 1956 fewer than ten vessels had called at Elath, for Egypt maintained a blockade of the port. This blockade was enforced by an armed customs post on Sinai peninsula at the entrance to the gulf (Ras Nusrani) near Sharm el Sheikh, and by Egyptian garrisons on the islands of Tiran and Sanafir (Fig. 5). These waterless islands are uninhabited. Most maps show them as part of Saudi Arabia, although Egypt has claimed sovereignty since 1907. Egypt also claims territorial waters up to a distance of six miles; all passages into the Gulf, especially the important Enterprise Channel, would thus be within Egyptian territory. With these claims and the continuance of a legal state of war with Israel

FIG. 5. Tiran and Sanafir.

Egypt tried to bar traffic proceeding to Elath. Egypt has similarly barred Israeli traffic in the Suez Canal. In view of the armistice agreements with Egypt, Israel has repeatedly protested against this interference. Israel regards the entrance to the Gulf as an international waterway akin to the Suez Canal, or the passage between Corfu and Albania, where the free and unrestricted movement of ships must be permitted. After several incidents in which British and American vessels proceeding to Aqaba were fired upon by Egyptian batteries, the British and American governments concurred with the Israeli point of view. During the 1956 Sinai campaign Israel occupied the area of Sharm el Sheikh, as well as Tiran and Sanafir, to assure unrestricted access to Elath. Although the legal position on access to the Gulf of Aqaba has not been fully clarified, the United Nations may now assure this unrestricted access after the withdrawal of Israeli troops from the area.[12]

The question arises whether Elath will handle a larger volume of traffic if access to the port is unrestricted. Cargo handled at Elath destined for the settled portions of Israel has to travel overland a distance exceeding one hundred and sixty miles, and effective costs of inland transportation are about as high as from Aqaba to Amman.[13] As the contiguously inhabited parts of Israel can be reached more cheaply through the ports of Haifa or Tel Aviv/Jaffa, almost all Israeli maritime traffic can be handled more economically through these ports. This includes Red Sea and Indian Ocean traffic, despite the incidence of Suez Canal transit fees. Even when the Suez Canal was closed to Israel, shipment or transshipment of this traffic via Capetown and Gibraltar was advantageous. For these reasons it seems that only bulk cargo destined for Elath and adjoining parts of Southern Israel, such as crude oil, petroleum products, and building materials or exports of minerals, can be handled economically through this port.

It is now planned to construct an eight-inch pipeline from Elath to Bersheba, the center of administration in the south of Israel's Mediterranean plain.[14] This pipeline would deliver imported petroleum products to southern Israel and would also be used to transport imported crude oil to Bersheba; from there rail tank cars would transport the crude oil to a refinery at Haifa. Crude oil delivery with three breaks in the transportation pattern (pipeline to tanker, tanker to pipeline, and pipeline to tank car) is not economical,[15] and presumably shipments of this nature would only take place in emergencies. This method of transporting crude oil would be even more uneconomical should the existing pipeline from Iraq to Haifa recommence operation (closed since the beginning of the Arab-Israeli war). A recent plan to build a large diameter (twenty to thirty inches) pipeline from Elath to a Mediterranean port

[12] *Report of the International Law Commission, Eighth Session,* United Nations General Assembly, A/CN.4/104 (New York, 1956), p. 60, par. 4.; also *Report of the Secretary General,* United Nations (New York, Jan. 25th, 1957), part II, par. 24.

[13] To encourage the development of Elath a government subsidy reduced the trucking rate Tel Aviv/Elath to about ten dollars for building components, etc., in 1953–54. Theoretically ocean freight rates to Elath should equal Aqaba rates.

[14] *Petroleum Press Service,* Vol. XXIV, No. 1 (London, January 1957), p. 34.

[15] "Investigation of Concentration of Economic Power," *Hearings before the Temporary National Economic Committee,* 76th Cong., 2nd sess. (Washington, D.C., Sept., 26th, 1939), Part 14. These cost patterns do not appear to have changed since then; see Alexander Melamid, "Geographical Distribution of Petroleum Refining Capacities: A Study of the European Refining Program," *Economic Geography,* Vol. 31, No. 2 (April 1955), pp. 168–78.

in Israel has been dropped, as experience has shown that for very large tankers the shorter Suez Canal route is now no longer economical compared with the all-ocean route around the Cape of Good Hope. Pipeline transportation across Israel would increase total transportation costs above Cape of Good Hope transit costs.[16]

TABLE 2.—RELATIVE UNIT COST OF SHIPPING OIL FROM THE PERSIAN GULF TO EUROPE[1]
(Cost of transporting one ton of oil in 19,500-ton tanker through the Suez Canal: 100)

Tanker's dead weight in tons	Via Suez Canal	Via Cape of Good Hope
19,500	100	139
32,000	88	118
38,000	82	103
45,000	85[2]	91
65,000	loaded passage impossible	85
100,000	loaded passage impossible	75 (estimated)

[1] Source: *The Oil Forum*, Fort Worth, January 1957, p. 23.
[2] Incompletely loaded to permit passage.

Some building materials have already been imported through Elath, and with the end of the blockade this traffic can be expected to grow. The increasing use of gypsum obtained from nearby quarries will, to some extent, limit the volume of this traffic. Copper ores mined by the ancients have been rediscovered at Timna, about twenty miles from Elath. Whether these and other mineral deposits in the area (iron ore, glass-sands, etc.,) can be mined economically and shipped through Elath remains open to doubt. The search for oil in Wadi Araba has been unsuccessful so far. Elsewhere in the area of the Gulf Pre-Cambrian rocks predominate which make petroleum discoveries unlikely. Phosphates and potash obtained farther north in Israel can be shipped more economically through Mediterranean ports. Efforts to find markets for these minerals in countries reached by shipment through the Red Sea have failed. The limited supplies of well water available in the region of the Gulf are brackish and unsuitable for continuous agricultural pursuits other than date cultivation, and possibly beets, spinach, and alfalfa. Development of such agricultural activities cannot be expected to affect Elath port traffic materially.

Fishery development in Elath has been very limited so far. Both Egypt and Saudi Arabia claim territorial seas up to a distance of six miles from shore and prohibit fishing by Israeli boats in their waters. (Jordanians are permitted to fish in Egyptian waters.) In view of the narrowness of the Gulf, coastal fishing from Israel is in fact restricted to the area close to Elath. Here the prevalence of northerly winds makes for poor fishing.[17] Whether the end of the blockade will result in long-distance trawling activities cannot be forecast. Generally, fishing in the Red Sea and adjoining portions of the Indian Ocean is not very remunerative, for about 65 percent of the catch is inedible. With the opening of the Suez Canal to Israeli vessels, trawling in the Red Sea and beyond by boats from Israeli Mediterranean ports may become more economical than trawling from Elath, since these ports are located closer to areas of consumption.

For all these reasons it is not surprising that Elath has not developed until now into a major maritime center. Substantial growth in the future cannot be expected. For the time being road communications to the settled parts of Israel are poor, and most traffic moves by air. The plan to build a railroad from Bersheba has been shelved. Despite the granting of tax reductions to settlers no significant economic activities, other than some fish processing (for food and fertilizer), and a seaside hotel catering primarily to winter visitors, have been attracted to the village. As in the Crusaders' Aqaba, a small trade in seashells has been developed.

EGYPT AND SAUDI ARABIA

Although an all-weather road was built from the Suez Canal to the police post at Taba near Gezira Firoun, there has been no economic development on the Egyptian side of the Gulf. Taba is also connected by rough and frequently very steep motor-tracks to the oases near the mouth of Wadi el Arish. According to the

[16] By ton miles, pipeline transportation costs are substantially higher than ocean tanker costs. For sources see fn. 15 above.

[17] According to local information fish drift with the wind. After a rare persistent south wind, fishing close to Elath is good and many different types of fish as well as sharks are caught. Excellent *langoustes* (lobsters) are also trapped.

armistice agreement with Israel this route cannot be utilized for military purposes except to supply specific small garrisons in the area.[18] Neither Taba nor Dahab, a village with the best anchorage in the lower portion of the Gulf, have water-borne traffic or local fishing. Dahab, capital of a Bedouin tribe, has the largest date-palm groves south of Aqaba but is inhabited only during the date harvest season.[19] Traffic to Dahab from Suez moves by a very rough track, which passes near St. Catherine's Monastery, located close to the highest point of Sinai (8,530 ft.). Oil production in western Sinai seems to have had no economic repercussions on the other side of the peninsula.

Since Saudi Arabia does not permit any land traffic south from Aqaba, occasional cargoes from Jeddah are moved by converted war-surplus landing ships which run ashore at the mouth of wadis, for example, near Haqal. Goods are then delivered by truck to inland oases. Although no information on cost is available, this method of transportation appears to be more expensive than shipment through Aqaba. The proposed rehabilitation of the Hejas railroad south of Maan through the border town of Mudawwara probably will diminish this traffic as well as the movement of pilgrims through Aqaba.

CONCLUSIONS

Considerations of military strategy are sometimes mentioned as a cause of political interest in the Gulf. Control of the region by a state established in the settled areas to the north would sever land connections between Egypt and Arabia. A severance of this nature suited the Crusaders; however, it never interrupted communications between their adversaries' dominions in Egypt and Syria. British experts do not appear to have been attracted by the idea of severance, for in 1938 Jarvis reported only very limited interest in the retention of southern Palestine and the head of the Gulf of Aqaba as a British crown colony.[20] The small British garrison at Aqaba was established quite independent of such considerations at Jordanian request.[21] Whether the present geographical separation of Egypt and Jordan is strategically significant is doubtful, for during the Arab-Israeli war (1947–49) the area southeast of Bersheba was militarily entirely insignificant. During the 1956 Sinai campaign Elath and the area of Israel draining to the Gulf of Aqaba were used as a basis for the invasion of Egypt. However, due to the roughness of the terrain the main Israeli attack was launched from bases farther north.[22]

Despite the small number of examples it appears that in determining the patterns of the political geography of the region purely strategic considerations have been less significant than the desire for trade with the East. In spite of strenuous efforts by several states, trade with the East was hardly ever realized. To develop transit trade by modern means of transportation is entirely uneconomic, if other routes are available. The use of the Gulf as a backdoor to the Levant is economic only if its Mediterranean ports are closed.[23] Since use of the Gulf can be relatively easily prevented by aerial bombardment, its utilization in modern warfare is also doubtful. Thus both in war and in peace the Gulf appears to have little economic value except for limited fishing activities and the handling of bulk cargoes for points located relatively close to its shorelines. The present traffic pattern of the Gulf is therefore due to the peculiar status of the southern

[18] *United Nations Security Council*, S/1264 (23 February 1949), Corrigendum (11 March 1949), Article VII, No. 3, Article VIII No. 4.

[19] G. W. Murray, *op. cit.*, pp. 146, 154. Mr. Murray reports on a visit to Dahab in 1929. Conditions do not appear to have changed since then. Five miles south of Dahab is the most northerly mangrove swamp in the world (p. 154). Additional information from J. Daumas, *La Peninsule du Sinai* (Cairo, 1951).

[20] Major C. S. Jarvis, "Southern Palestine and Its Possibilities of Settlement," *Journal of the Royal Asian Society*, Vol. 25 (1938), p. 205.

[21] *The Economist* (London, December 8, 1956), p. 867.

[22] Information from the government of Israel; also articles by Col. Robert Henriques, *Daily Telegraph* (London, Jan. 7, 8, 9, 10, 1957). The roughness of the territory invaded from bases near Elath is indicated by the high rate of vehicle breakdowns in the advance towards the Suez Canal and Sharm el Sheikh. Farther north vehicle breakdown rates were much lower.

[23] The recent history of the Egyptian Red Sea port Safaga exhibits the same pattern. During World War II, when shipment to Egyptian Mediterranean ports or Suez was dangerous, Safaga was developed as a modern port and connected with the Egyptian railroad system at Qena in Upper Egypt. After the eviction of German armies from Africa the port rapidly declined. Today the port is only rarely used, for despite the distance, Upper Egypt is much better served by Mediterranean ports.

Middle East states which are neither at war nor at peace with each other. The future use of the planned pipeline from Elath to Bersheba will also conform with this pattern.

According to the German school of geopolitics, largely derived from Ratzel's *Anthropogeographie*, geography is supposed to determine the political actions of man.[24] Following these ideas an American Middle East expert recently stated: "The science of geopolitics finds nowhere better laboratory conditions than in the Middle East. There the movements of people of three continents . . . converge under the urge of geographical configuration."[25] Many geographers will deny the existence of a "science of geopolitics." However, this case study shows that throughout history all significant states established in settled areas to the north of the Gulf of Aqaba have taken similar action to extend their territories to the shores of this arm of the Red Sea. So far these efforts have never produced any permanent or significant results. Has geography, as interpreted by the geopoliticians, thus misled man throughout history?

[24] Friedrich Ratzel, *Anthropogeographie* (Stuttgart, 1899).

[25] Halford Hoskins, *The Middle East: Problem Area in World Politics* (New York, 1954), p. 285.

WORLD PATTERNS OF MONTHLY SOIL TEMPERATURE DISTRIBUTION[1]

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TO assemble the data and to summarize adequately the literature on soil temperature would require a gleaning from studies by climatologists, agronomists, foresters, ecologists, soil scientists, civil engineers, architects, and others. To climatologists the soil, absorbing heat by day and supplying a net flow of warmth to the atmosphere by night, is a heat reservoir of great capacity, and hence often acts as a temperature stabilizer. The ground influences not only the microclimate and topoclimate of a place, but also the air masses involved in general circulation. To students of biological sciences soil temperature is, in many instances, a more important habitat factor to the living world than air temperature; therefore, much effort has been directed to modify it to man's advantage. The engineers' interest in ground-temperature study lies primarily in the effect of frost and extreme temperatures on engineering designs.

In spite of the importance to many a line of scientific inquiry and the welfare of human activities, studies on soil temperature lag far behind those on air temperature. It has been deplored that the customary practice of weather stations, seeking only the data desired for synoptic analysis, has limited the climatological applications.[2] Only rarely does a meteorological station observe soil temperature; the records have to be sought elsewhere. The writer has collected from published literature, and, through the kind cooperation of weather services, agricultural stations, water works, and other sources, monthly soil temperature data of 780 stations throughout the world (Fig. 1). It is the purpose of this paper to map and to discuss these data.

LIMITATIONS OF THE RECORDS AND METHODS OF TREATMENT

The scarcity of soil temperature observations necessitates scraping together all available ones. This mass of data is, however, limited

[1] The research reported in this article has been sponsored by the Quartermaster Research and Development Center under contract DA 19-129-QM-348. The writer wishes to thank Drs. C. F. Brooks and V. Conrad for their suggestions in the preparation of this article.

[2] H. L. Landsberg and W. C. Jacobs, "Applied Climatology," in *Compendium of Meteorology* (American Meteorological Society, 1951).

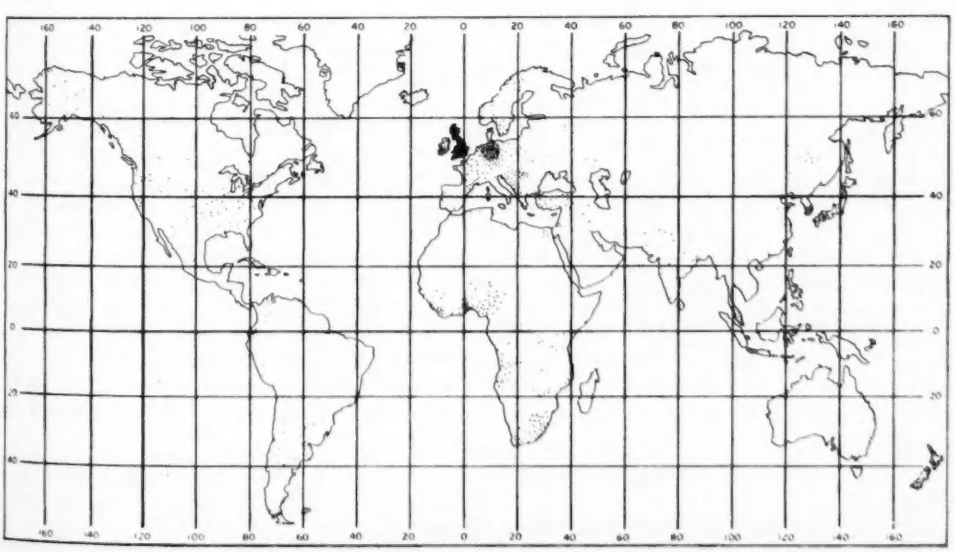

FIG. 1. Location of soil temperature stations.

in usefulness owing to the inhomogeneity in the time of observation, the ground conditions, the length of record, and the depths at which the thermometers are buried.

In most stations soil temperatures are read only once, twice, or three times a day. The time of observation also varies greatly. Obviously the value thus derived differs from the true daily mean of 24 hourly readings. Analysis of the soil temperatures at Zurich, Switzerland, in 1952[3] indicates that at 2 and 10 cm depths the monthly mean derived from two readings at 8h and 20h differs from the true mean by 0.4°C. on the average and 0.8°C. in the extreme month. The differences, however, diminish rapidly with depth. At 30 cm depth the diurnal range has already decreased to less than 2°C. so that at many British stations readings are taken once daily at 9 a.m. at this depth or below. Therefore, it seems justified that corrections be applied only to the records in topsoil based on one or two daily readings. The correction values are determined by analyzing the records in an appropriate nearby station.

Soil temperature stations have been located in different types of sites. Agronomists tend to take readings in the furrow slices under crop cover. An engineer in a water department, however, desires records at deeper depths, under pavement or in bare ground. The influence of ground cover on soil temperature is difficult to assess. For the sake of comparison, therefore, well-drained, bare, level land is regarded as the norm. Observations in loamy soils are preferred, except in areas where clayey or sandy soils are the representatives of such azonal soils as alluvium or desert sand.

There are few long series of soil temperature. Fortunately, the variability of soil temperature, except at or near the surface, is smaller than that of air temperature, as is indicated in Table 1. Therefore, a shorter period of soil temperature than of air temperature record is required to establish a stable mean. Furthermore, a shorter record can be "lengthened" by getting the difference between its mean and that of the same year in the appropriate long-period station and then applying this difference to determine the probable long-term mean for the short duration.

In 1947 the International Meteorological Committee recommended that the standard depths for earth temperature measurements should be 10, 20, 50, and 100 cm. This recommendation, however, has not been widely adopted, as the subsequent records collected by the writer indicate. For stations where there are no data at the desired depth those for other depths are used as a guide for interpolating or for applying a correction for temperature lag.

CONSTRUCTION OF THE MAPS

The existing soil-temperature network does not permit the construction of maps on a medium or large scale, except in such areas as the British Isles, Germany, New Zealand, South Korea, Nigeria, and a few others. In this study a small-scale map on the Miller composite projection is used; this is a compromise between a conformal and equal area projection and has been adopted by the World Meteorological Organization in the proposed *World Climatological Atlas*.[4]

No attempt is made to map mean annual soil temperature at any depth, because it is practically the same throughout the soil profile and, in most instances, differs only slightly from the annual air temperature. Furthermore, such maps are comparatively of little practical value. Soil temperature maps for 10, 30, and 120 cm depths are constructed for each of the four months, January, April, July, and October (Figs. 2–13). These depths are selected primarily on account of the availability of data. At or near the ground surface the wide fluctuation of temperature renders records based on two or three daily readings a day of little value. Below 120 cm the temperature waves can be fairly accurately inferred by applying Fourier's theory of heat conduction.[5]

The distribution of soil temperature stations is, at best, an uneven one. Large blank areas are found in the Amazon Basin, Tibet, Sinkiang, Mongolia, the Sahara Desert, and elsewhere. It would be guesswork to try to fill the gaps by relying solely on soil temperature

[3] B. Primault, "Les températures dans le soil, à Zurich, au cours de l'année 1952," *Annalen der Schweizerischen* (1953), pp. 2–10.

[4] World Meteorological Organization, *First Report of Working Group on Climatic Atlases* (The Laboratory of Climatology, Centerton, New Jersey, 1956), p. 17.

[5] R. Geiger, *The Climate Near the Ground* (Harvard University Press, 1950), pp. 27–29.

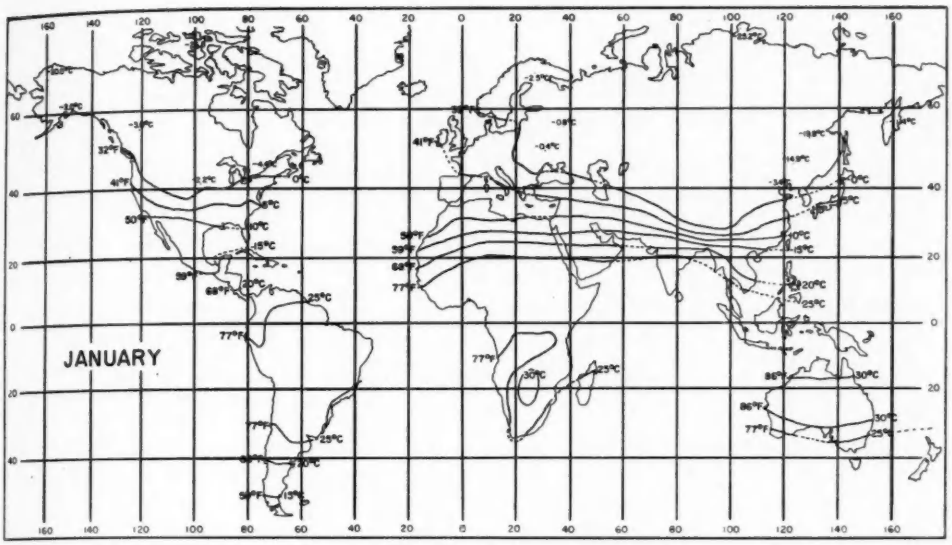

FIG. 2. Soil temperature at 10 cm depth—January.

data. Fortunately, we have detailed maps of air temperature, precipitation, snow cover, and the like to guide the drawing of isotherms. The isotherms are spaced at 5°C. intervals. Isotherms of temperature below 0°C. are omitted owing to the insufficiency of data; only the actual values of a few selected stations are given. This omission is, however, not a serious drawback. Although most soil will not freeze until –4°C. is reached,[6] 0°C. is an important threshold temperature, and once the tempera-

[6] G. J. Bouyoucos, "Degree of Temperature to Which Soil Can Be Cold Without Freezing," *Journal of Agricultural Research* (1920), pp. 267–269.

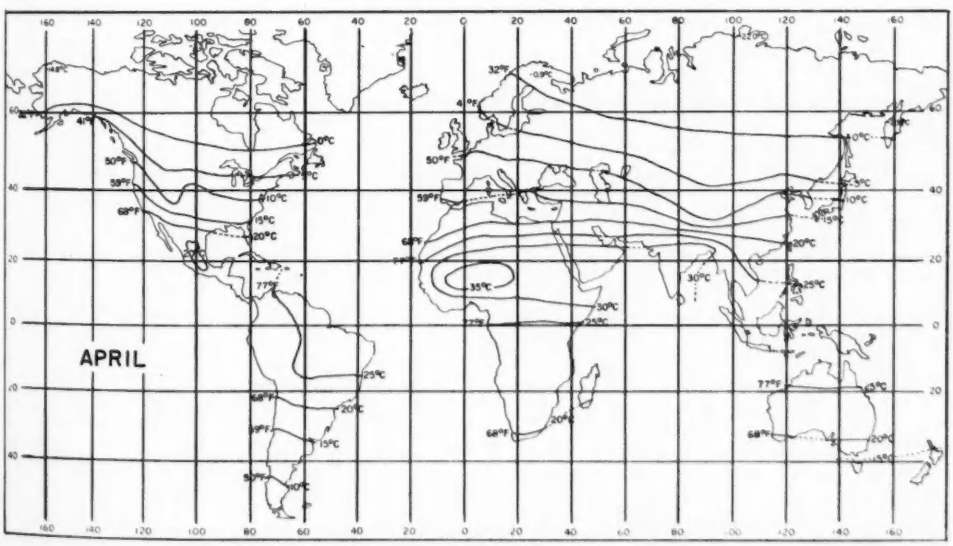

FIG. 3. Soil temperature at 10 cm depth—April.

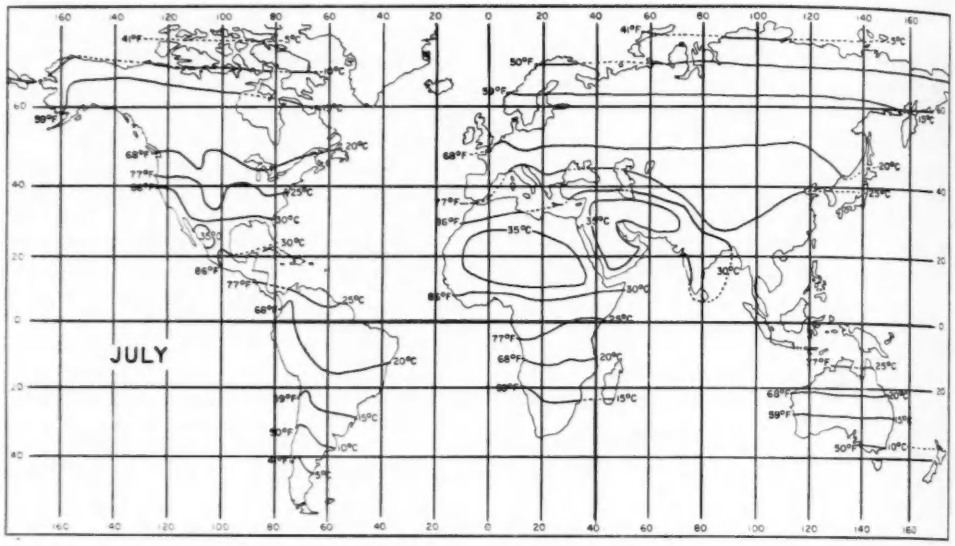

FIG. 4. Soil temperature at 10 cm depth—July.

ture is below freezing point its differentiation is of little biological significance.

Complications caused by minor topographic features cannot be shown on a small-scale map. The patterns depicted on these maps are thus highly generalized. However, the effect of topography on soil temperature at deeper layers is much less than that on air temperature. At 30 cm depth or below the small-scale maps are representative of the actual conditions.

SOME REMARKS ON THE MAPS

January. The 0°C. isotherms of soil temperature at 10 cm depth follow closely those of

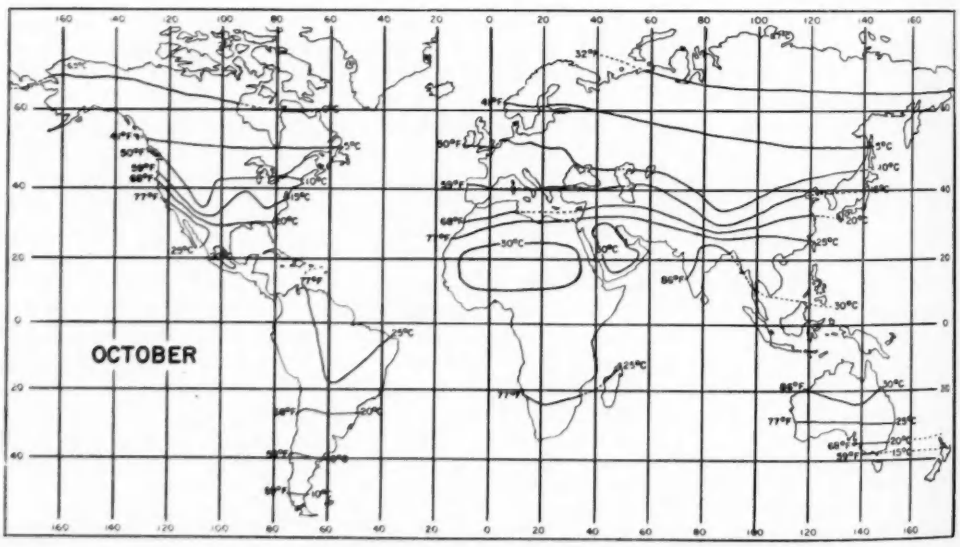

FIG. 5. Soil temperature at 10 cm depth—October.

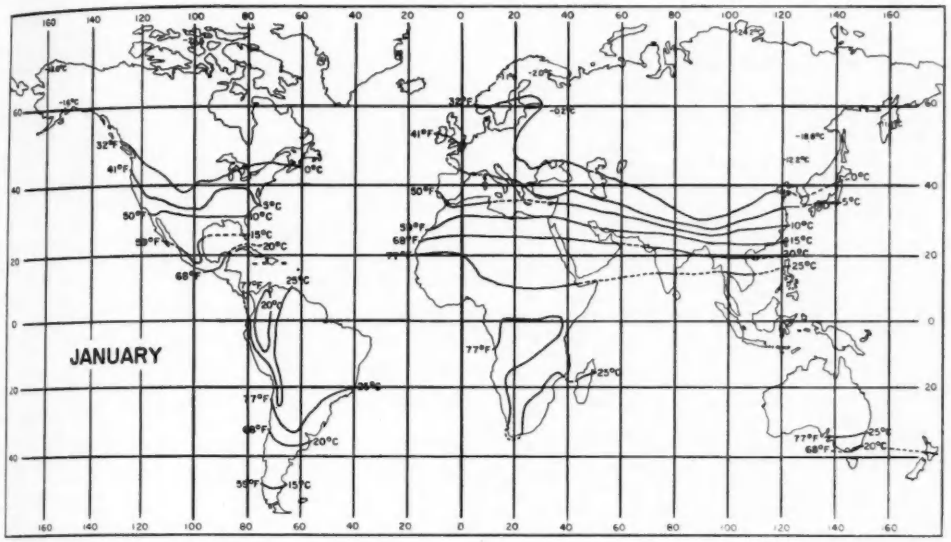

FIG. 6. Soil temperature at 30 cm depth—January.

air temperature, except in western Europe and eastern North America, where the soil temperature is the higher. In these two areas the insulating effect of relatively abundant snowfall prevents the lowering of soil temperature. At 120 cm depth, where the temperature is not the result of the current temperature at the surface but of the weakened remnant of the relative warmth of early winter, the 0°C. isotherms lie much farther poleward.

The heat wave in the ground is propagated downward with a time lag. At 120 cm the annual temperature wave is delayed for over a month. In January in northern Nigeria and

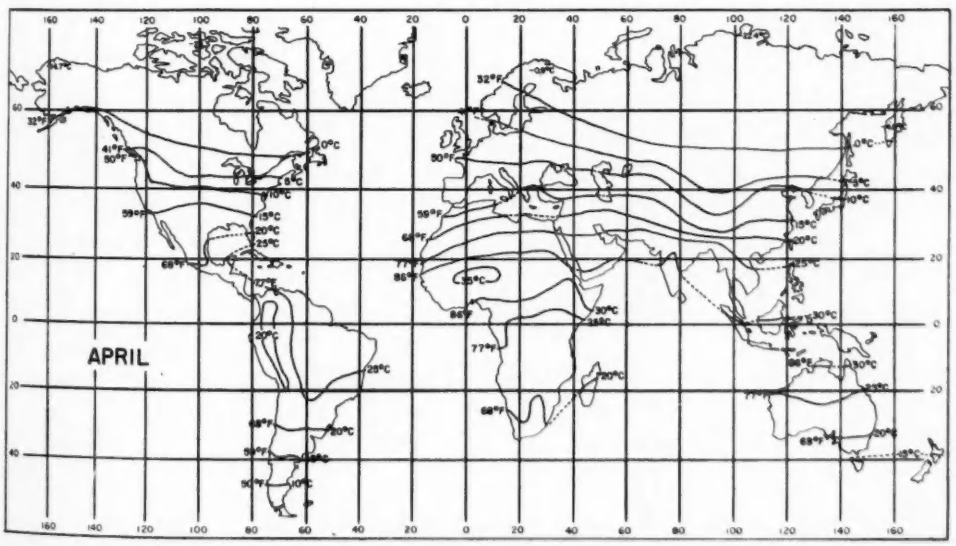

FIG. 7. Soil temperature at 30 cm depth—April.

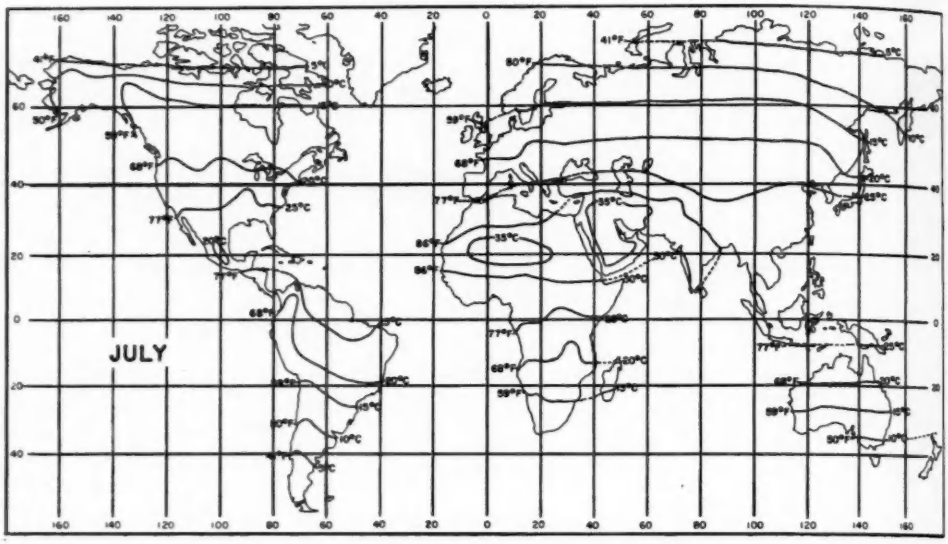

FIG. 8. Soil temperature at 30 cm depth—July.

the adjacent area in French West Africa soil is warmer at 120 cm than at 30 cm and 10 cm depth. This is due to the fact that here the ground surface receives more heat in November and December than in January. At Bilma, French West Africa, for example, the air temperatures for November, December, and January are 22.2°, 18.3°, and 16.1°C., respectively.

April. Although the ground surface in the northern hemisphere warms up rapidly in April, the accumulated heat is still not sufficient to thaw the ice remaining underground in high latitudes. Therefore, while the isotherms for 10 cm and 30 cm have retreated

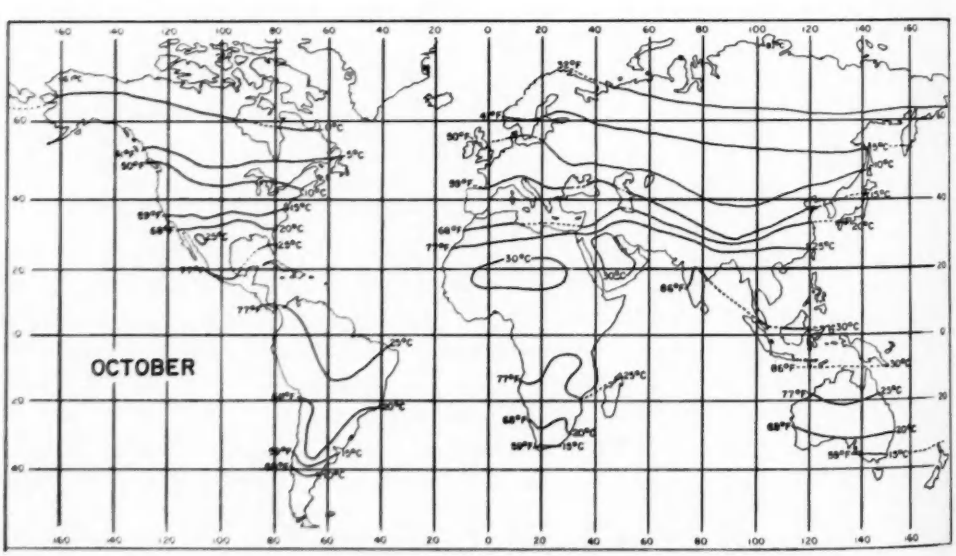

FIG. 9. Soil temperature at 30 cm depth—October.

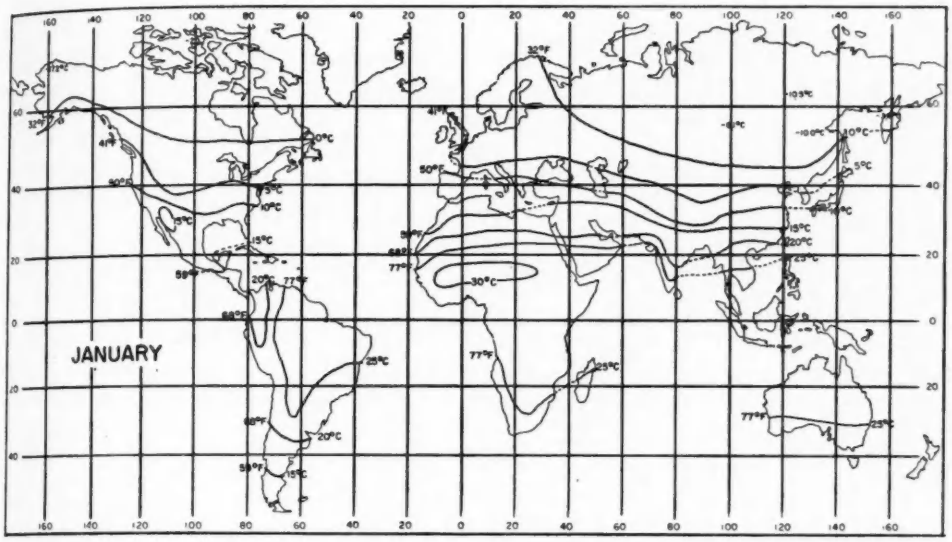

FIG. 10. Soil temperature at 120 cm depth—January.

poleward, those for 120 cm have retained practically the same position as in January.

A temperature stratification with a cold layer between two warm layers is found in many northern stations in April. In northern Manchuria the remaining frozen soil is found at about 120 cm depth; in some stations in southern Alaska the coldest spot in the soil profile lies some 50 cm below the ground surface.

The effect of cold ocean currents on the air temperature is well known. In consequence, isotherms of air temperature bulge conspicuously equatorward in California, south-

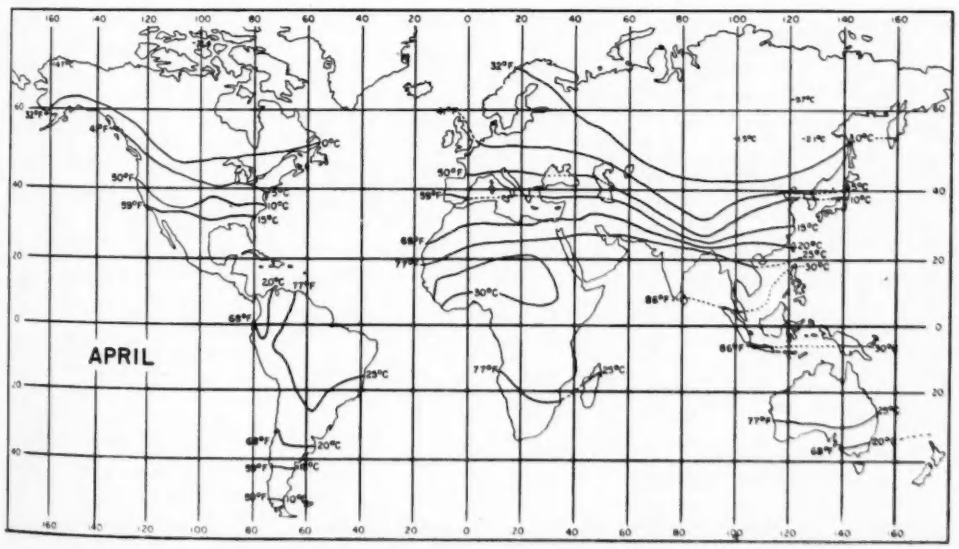

FIG. 11. Soil temperature at 120 cm depth—April.

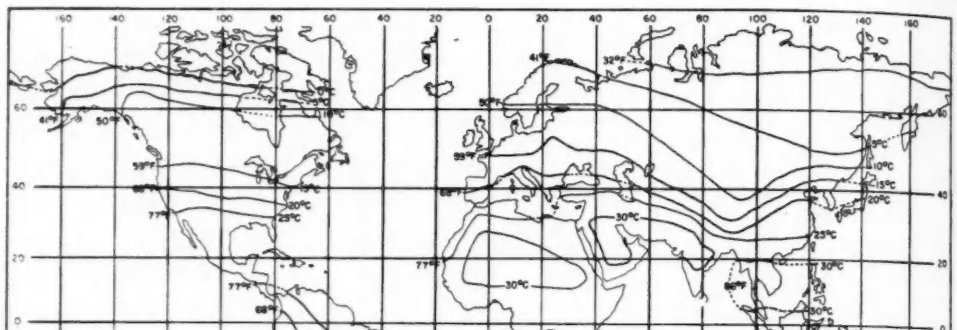

FIG. 12. Soil temperature at 120 cm depth—July.

western Africa, Peru, and other mid-latitude west coasts. A similar trend, however, is missing on soil temperature maps. This is explained by the fact that soil temperature is more responsive to solar radiation than air temperature and that the effect of imported air masses on ground temperature is rather small.

July. In summer the difference between air and soil temperature can be excessive. It has been reported that the absolute maximum surface temperatures exceed 80°C. in low latitudes and 60°C. in Scandinavia and other northern lands. In low-latitude deserts soil temperature is much in excess of the air tem-

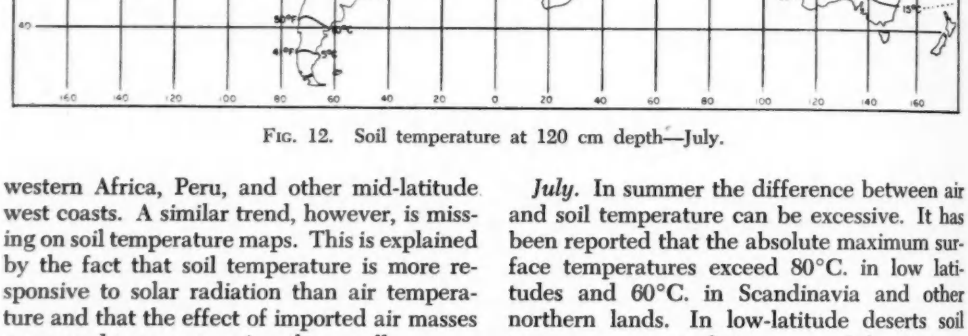

FIG. 13. Soil temperature at 120 cm depth—October.

perature. Generally, in the northern hemisphere the depth to which the soil in July is warmer than the air increases from about 10 cm at around 60° N to 20–40 cm in mid-latitudes, and to more than 80 cm in the arid tropics. In a few stations in India this depth extends to over 200 cm.

In summer wet soils are relatively cold. The relatively low soil temperatures in the Western Ghats in India provide a good example. Although the effect of a summer rain on daily minimum temperatures is small, maximum temperatures are lowered by it considerably. Kandasamy reported that in Ceylon the effect of a heavy rainfall was, on the average, to lower the next day's temperature at a depth of 30 cm by 2.2°C.[7]

October. Outside the tropics, the soil is warmer in October than in April in the northern hemisphere and vice versa in the southern hemisphere. Wet, cold ground in spring and the remnant of prolonged heating in summer account for the difference, which usually increases with depth down to more than 120 cm. At Leningrad, for instance, the difference in temperature between October and April for soils at 10 cm, 30 cm, and 120 cm are 1.9°, 4.7°, and 7.1°C., respectively.

The temperature stratification prevailing in April in many northern stations is reversed in October: a warm layer between two cold layers. Generally, the warm layer in autumn is deeper than the cold layer in spring. The warm layer lies at about 120 cm depth at Ithaca, New York, and at 210 cm at Anchorage, Alaska. A notable exception to this normal temperature stratification is found along the California coast, where it is destroyed by the very high temperature in the top soil. In October the relatively high surface-soil temperature along the California coast is of ecological significance. For many plants, soil temperature is more representative of the growing season than air temperature.

TABLE 1.—STANDARD DEVIATIONS OF JANUARY AND JULY AIR AND SOIL TEMPERATURES (C. deg.) FROM LONG PERIOD MEAN AT THREE STATIONS

	Seoul, Korea 1926–45		Singapore, Malay 1931–40		Dublin, Ireland 1921–40	
	Jan.	July	Jan.	July	Jan.	July
Air	1.86	1.28	2.26	2.22	2.81	2.17
Soil, 10 cm	1.21	1.32				
Soil, 30 cm	1.10	1.11	0.90	0.74	1.83	1.63
Soil, 100 cm	0.92	0.87				
Soil, 120 cm			0.49	0.34	1.15	1.20

[7] A. P. Kandasamy, "Underground Temperature at Colombo Observatory," *The Ceylon Journal of Science*, Section E, Meteorology (1937), pp. 93–105.

LUMBERING AND WESTERN LOUISIANA CULTURAL LANDSCAPES

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THE multiple origins of cultural forms and patterns seen in Louisiana landscapes are well known and have been mentioned in earlier studies.[1] Lands adjacent to the lower Mississippi and neighboring streams have long been areas of convergence for cultural invasions. The introduction of new traits has continued, in some cases on a large scale, into the twentieth century.

Examination of western Louisiana cultural landscapes indicates that the single most important developmental agency has been the lumber industry. The massive and overwhelming march of the mills into the district introduced forms and patterns which are both notably persistent and widely distributed. The pre-existing cultural base could not absorb them and subsequent change has failed to obscure them. Although the significance of lumbering in Louisiana geography has long been recognized, no systematic attempt to measure its full contribution has yet been made. The passage of time renders this work more difficult. The number of people with personal experience of the industry in its most active stages decreases and the original forms and patterns become more indistinct or disappear.

This paper summarizes the results of an inquiry into the nature of landscape elements introduced into western Louisiana by lumbering during its most intensive phase. The area covered is the longleaf pine forest[2] (Fig. 1), sometimes called the Calcasieu Pine District.[3] Variations in climate and geology occur in this region, but in its original state it presented within its bounds a constant element, the longleaf forest. All establishments fixed here by the lumber industry had a single purpose: the processing of longleaf pine.

Sawmill towns were centers of concentration for landscape elements associated with lumbering, and twenty of them were studied in detail. Although most of the towns have disappeared, their former residents who still live in western Louisiana in considerable numbers proved to be interested, cooperative and accurate informants. Field trips to abandoned town sites revealed in almost every case much evidence of former occupation: mill foundations, ponds, overgrown streets, and like features. Aerial photographs yielded much information and were used extensively in the preparation of maps and in conversations with informants.[4]

HISTORY OF THE INDUSTRY

The historic record of lumbering in western Louisiana comprises three principal phases: a long early period of slow development along waterways; a shorter second period of intensive activity as the railroads were built into the forests; and a third phase, the present, in which operations are geared to reduced timber stands, small mills, and motor transport.

Forest products were exported from Louisiana as early as 1726,[5] and a large local demand led to cutting on an extensive scale. Initial industrial development occurred along the main streams, which served to supply the mills and move their products. Lake Charles became a notable sawmilling center,[6] and great quanti-

[1] F. B. Kniffen, "Louisiana House Types," *Annals*, Association of American Geographers, Vol. 26 (1936), pp. 179–93. Also noted by J. S. Kyser in "Terrebonne Parish, Louisiana: A Subdelta of the Mississippi," *Annals*, Association of American Geographers, Vol. 41 (1951), p. 169.

[2] C. A. Brown, *Louisiana Trees and Shrubs* (Baton Rouge: Louisiana Forestry Commission, 1945), p. 6. The western district is one of three original longleaf forests shown by Brown. A second lay between the Red and Ouachita rivers and a third occupied part of the Florida Parishes.

[3] G. B. Hartman, "The Calcasieu Pine District of Louisiana," *Ames Forester*, Vol. 10 (1922), pp. 63–73.

[4] G. A. Stokes, "An Application of Aerial Photographs to Field Research in Cultural Geography," *Photogrammetric Engineering*, Vol. 20 (1954), pp. 802–4.

[5] W. A. Roberts, *Lake Pontchartrain* (New York: Bobbs-Merrill, 1946), p. 51.

[6] S. H. Lockett, *Louisiana As It Is* (Louisiana State University: unpublished manuscript, 1873), p. 140. Lockett goes on to say: "All around Lake Charles and for several miles up both branches of the Calcasieu the sawmills are so thickly located as to give the whole country the appearance of an immense lumber yard. There are seventeen steam sawmills within a space of ten miles in diameter. These saw and ship millions of feet of the best of pine, red and white cypress lumber yearly, giving constant employment to over sixty sailing vessels. This lumber trade is at present the principal source of wealth of the parish . . . ."

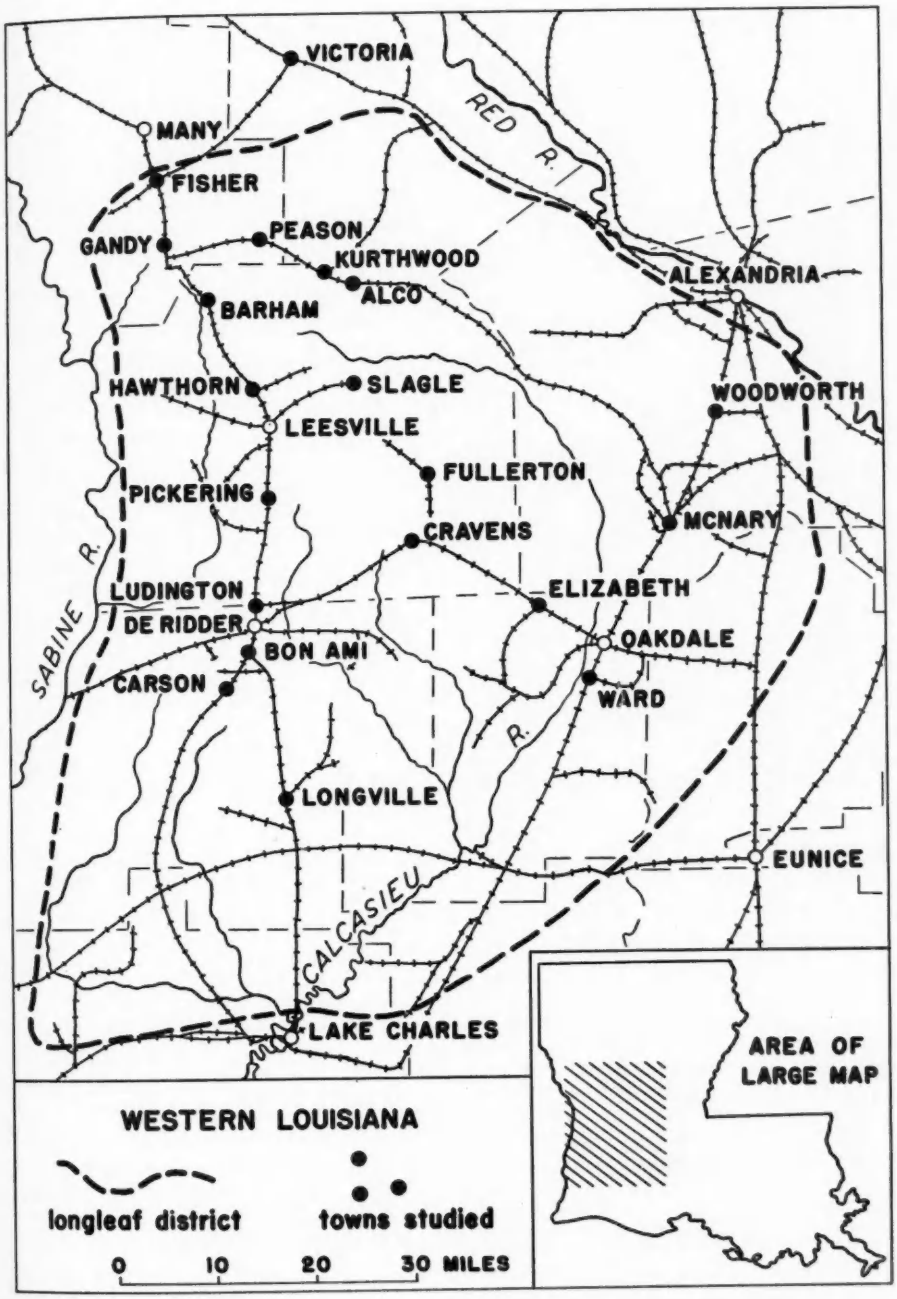

FIG. 1. Index map of the western Louisiana longleaf pine district covered in this study. Of the twenty sawmill towns shown only Fisher and Elizabeth remain. The railroad net is that which served the area in 1920.

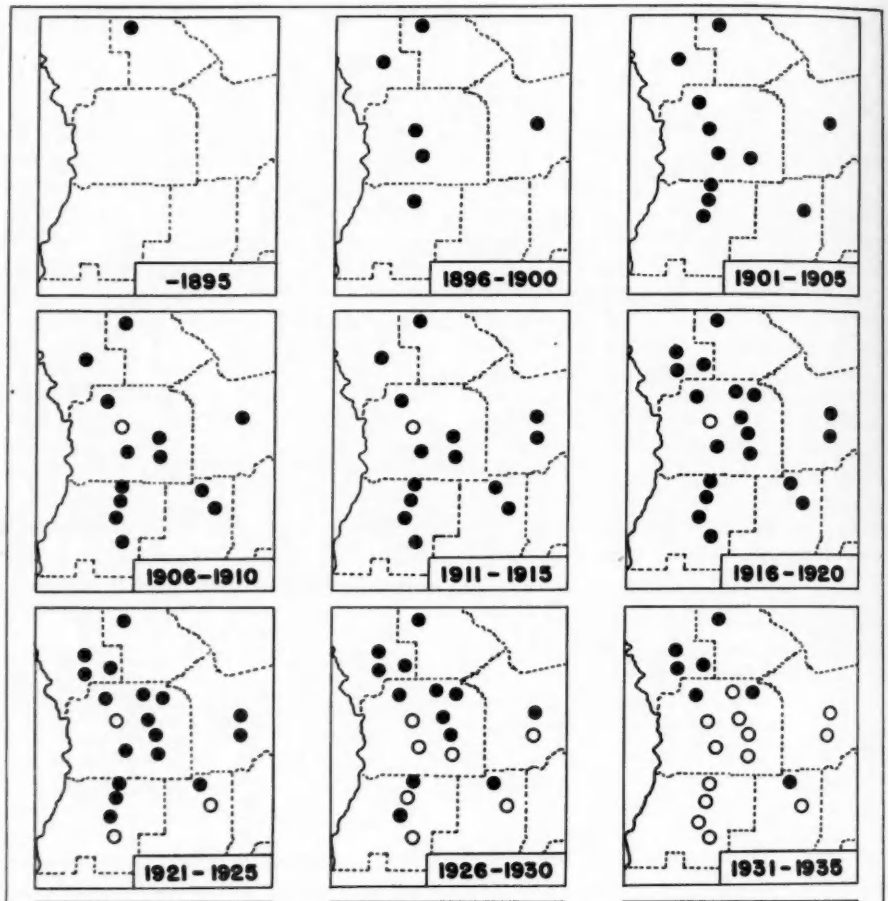

FIG. 2. A map series illustrating the rapid increase in the number of western Louisiana sawmill towns after 1895 and their equally rapid disappearance. The twenty settlements shown represent only a portion of the total number established in the area by lumber companies. Fisher, in Sabine Parish, is the only community still supported by a sawmill. The open circles indicate abandoned sites.

FIG. 3. A pyramidal company house at Woodworth, Rapides Parish. This and the other dwellings illustrated in this paper are original company-built houses and are still occupied. When the mills "cut out," the houses were dismantled or sold at extremely low prices. Many were bought and moved to new locations.

ties of pine and cypress were rafted down to the mills on the spring rises of the Sabine and Calcasieu.

In spite of early exploitation the pine forests of the Calcasieu district stood almost untouched in 1890. Longleaf covered more than 2,500,000 acres at the end of 1892, although in that year alone the mills around Lake Charles cut some 150,000,000 board feet.[7] The doom of these forests was foretold in 1884, when Sargent reported that:

> The country between the Mississippi River and the Rocky Mountains, now largely supplied with lumber from Michigan, Wisconsin, and Minnesota, must for building materials soon depend upon the more remote pine forests of the Gulf region or those of the Pacific coast. A great development in the now unimportant lumber-manufacturing interests in these regions may therefore be expected.
>
> . . .
>
> The most valuable forests of the state [Louisiana] are still almost intact. . . . Pine has also been cut along the Sabine River, from both forks of the Calcasieu, along the Red River in the neighborhood of Alexandria and Shreveport. . . .[8]

As northern forests dwindled railroads were built into west Louisiana pineries and made possible, after 1895, forest exploitation on a

[7] C. Mohr, *The Timber Pines of the Southern United States* (Washington: U. S. Department of Agriculture, 1897), p. 45.

[8] C. S. Sargent, *Report on the Forests of North America, Except of Mexico* (Washington: U. S. Department of the Interior, 1884), pp. 489 and 536. According to Sargent: "The principal point of manufacture is Saint [sic] Charles, in Calcasieu parish, on the southern border of the western pine forest. Lumber manufactured here is shipped east and west by rail, and in small schooners to Mexican and West Indian ports."

FIG. 4. Bungalows at Longville, Beauregard Parish.

greatly magnified scale. The logging railroads opened up hitherto remote areas and became "... a particularly potent force in the development of the pine forests of the south."[9] Some of the big mills could demolish the virgin timber of an entire section of land in a few weeks and railroad mileage grew accordingly. By 1904 more than 2,000 miles of logging railroads had been built in the South.[10] With the railroads came the company towns—sizable settlements[11]—built in great numbers throughout Louisiana timber lands and especially numerous in the western section. Near the "front," the scene of actual logging, were the lumber camps.

Western Louisiana had no industrial population in 1890, but this deficiency presented no particular problem to the lumber companies moving into the area. The decline of forest resources in northern states released large numbers of skilled workers and administrators, many of whom moved south with their employers. This group also included loggers, and one account mentions the employment of Swedes from the Lakes States in the lumber camps of west Louisiana and east Texas.[12] The native rural population provided the bulk of the labor force required. Most jobs could be filled with comparatively little training, and

[9] S. F. Horn, *This Fascinating Lumber Business* (New York: Bobbs-Merrill, 1943), p. 127.

[10] W. W. Davis, "The Yellow-Pine Lumber Industry in the South," *Review of Reviews*, Vol. 29 (1904), pp. 443–50.

[11] The company towns, though usually short-lived, often attained considerable size. Fullerton, in Vernon Parish, was established in 1906, and by 1910 had 1,238 residents. During the next ten years its population grew to 2,412, and the town was equal in size to Leesville, the parish seat. Operations at Fullerton ceased in 1926, and the census of 1930 listed only 148 inhabitants.

[12] Davis, *op. cit.*, p. 446.

FIG. 5. A shotgun house at Fisher, Sabine Parish. This dwelling has been enlarged by the addition of a lean-to.

many farmers were more than willing to exchange the insecurity of a small farm for the cash wages paid by the companies. Administrative personnel were invariably whites, while the skilled labor force included both whites and Negroes. The unskilled laborers were largely Negroes, with some whites, augmented occasionally by groups of Mexicans.

The development of a large industrial system, coupled with high demand and easy logging conditions, could result only in the rapid destruction of the forests. Under the "cut out and get out" policy of the time the speed with which the industry had grown was matched by the rapidity of its removal.[13] Along one railroad line 23 sawmills, each cutting more than 100,000 board feet a day, went out of existence in five years.[14] Sixteen large mills in Vernon and Beauregard parishes, employing at least 400 men each and with towns of 1,000 or more, had been abandoned by 1933.[15] Maps best indicate the transitory nature of the company towns (Fig. 2).[16] The virtual exhaustion of the virgin forests did not result in the extinc-

[13] The story of McNary, in Rapides Parish, is especially interesting. Operations ended there in 1924, and in less than two months the entire population of 3,000 was transferred by special trains to a new company town, McNary, Arizona, where work was immediately resumed.

[14] N. C. Brown and F. Moon, *Elements of Forestry* (3rd ed.; New York: John Wiley and Sons, 1937), p. 63.

[15] J. W. Cruikshank, *Forest Resources of Southwest Louisiana* (New Orleans: Southern Forest Experiment Station, 1939), p. 25.

[16] The short life span of the average sawmill town has been noted in other areas. Interesting articles which comment on the subject are: "The Cities and Towns of the High Plains of Michigan," by C. M. Brown in *Geographical Review*, Vol. 28 (1938), pp. 664–73, and "A Forest Tragedy," by S. T. Dana in *Munsey's Magazine*, Vol. 40 (1917), pp. 353–63.

FIG. 6. A derivative of the single log-pen at Fisher, Sabine Parish.

tion of the lumber industry as some had predicted. Succeeding years witnessed the emergence of the small portable mill as the major producer of lumber in the South. The small mill was no innovation, for plants of low capacity have long been active in this country. The significant change has been in the growing volume of lumber produced by small plants relative to the output of the larger mills. More than half the total pine production of 1929 was cut by small mills.[17] Only ten percent of the 557 mills operating in Louisiana in 1937 had a daily capacity of more than 40,000 board feet, and 68 percent of the lumber produced that year was turned out by the small mills.[18] The Louisiana Forestry Commission listed 496 active mills in 1946, and of that total only 69 cut more than 5,000,000 board feet of lumber yearly.[19] The team of motor truck and small mill has become the hallmark of lumbering in Louisiana, and the remaining large mills have come to rely heavily on the newer means of transportation.

The second of the three stages described above is geographically most significant, for in this phase of exploitation the lumbermen introduced cultural forms and patterns on a scale unequaled before or since. Many of these have persisted over wide areas, even though the combination of human and natural circumstances then prevailing no longer exists. Changes in vegetation, soils, and other elements of the physical setting were similarly profound and lasting.

[17] A. S. Boisfontaine, "The Small Mill—Its Awakening and Development," *Journal of Forestry*, Vol. 30 (1932), pp. 137–42.

[18] I. F. Eldredge, G. B. Ward, Jr., and R. K. Winters, *Louisiana Forest Resources and Industries* (Washington: U. S. Department of Agriculture, 1943), p. 4.

[19] *Forest Resources of Louisiana* (Baton Rouge: Louisiana Forestry Commission, 1947), p. 17.

FIG. 7. A double log-pen derivative at the Pickering site, Vernon Parish.

THE COMPANY TOWNS

Western Louisiana sawmill towns possessed a number of attributes which sharply distinguished them from older settlements. These characteristics, briefly summarized, are:

1. Orientation toward the performance of a single function so pronounced that the town almost invariably ceased to exist when that function could no longer be discharged.
2. A large mill plant.
3. A company-owned commercial district.
4. Residential sections, called "quarters," assigned on a racial basis.
5. Adoption, by the companies, of a few house types for company housing, and their construction in great numbers.
6. An extensive system of logging railroads linking the company towns and the forests.

Function. Almost every task performed in or about the company town had some part to play in supplying the mill with logs and converting those logs into lumber. Here were concentrated all the facilities, human and mechanical, for forest exploitation: large and efficient mills of high capacity, skilled administrators and technicians, and a large labor force. Unity of function contributed to the development of self-contained and effective settlements but was also responsible for their virtual extinction. When the town destroyed the forest nothing remained to justify its continued existence. Older settlements could discharge functions beyond the range of the lumber industry, and even absorbed those of the sawmill towns to a great degree, many acquiring sawmills and quarters as new appendages.

The mills. The mills themselves dominated the cultural landscape, including as they did the largest man-made structures in the area. The principal components of the plant were

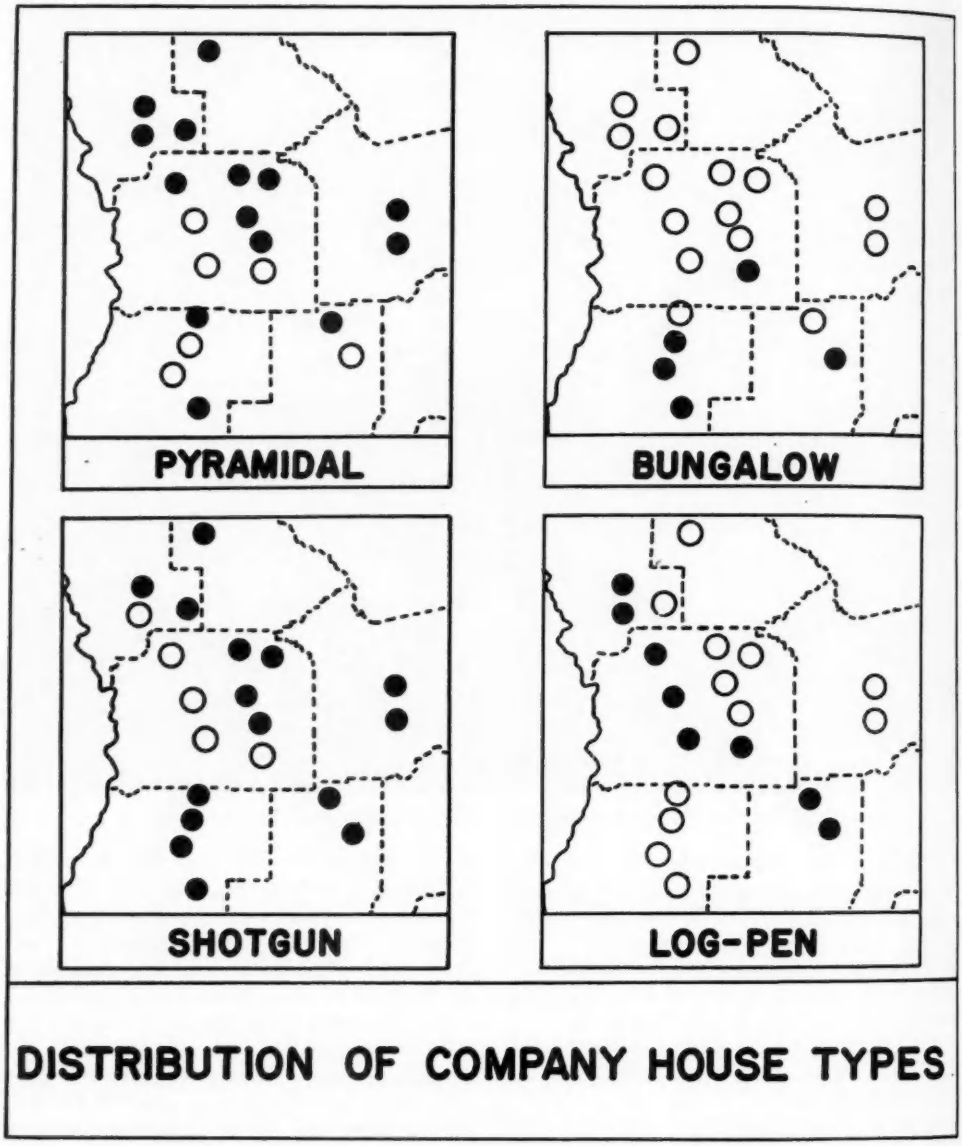

FIG. 8. The solid dots indicate the company towns studied in which each of the four basic house types occurred.

the pine mill and planer mill, and in their immediate vicinity were the dry kilns, lumber yards, and machine shop. The latter was, in its older form, a blacksmith shop, but as transport systems developed it grew into a large establishment capable of making major repairs to mill equipment and railroad rolling stock. Standpipes and generators at the mill usually furnished water and electricity for the entire settlement.

Ponds were almost invariably located at the mills, serving to clean the logs and as storage areas where reserves of logs could be accumulated against periods of bad weather or any

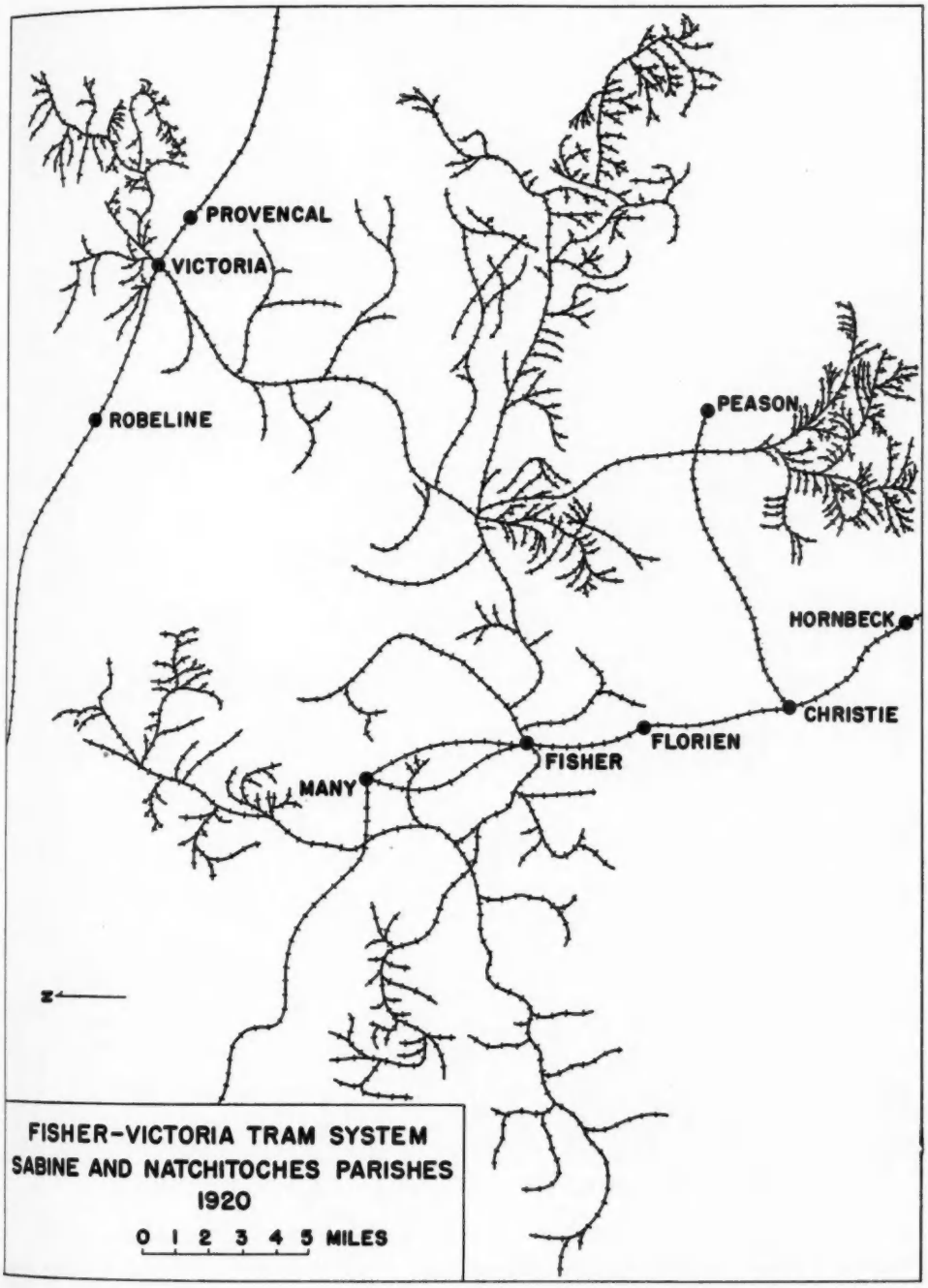

FIG. 9. A map of an extensive tram system copied from an original kept for many years by a logging superintendent working in the area.

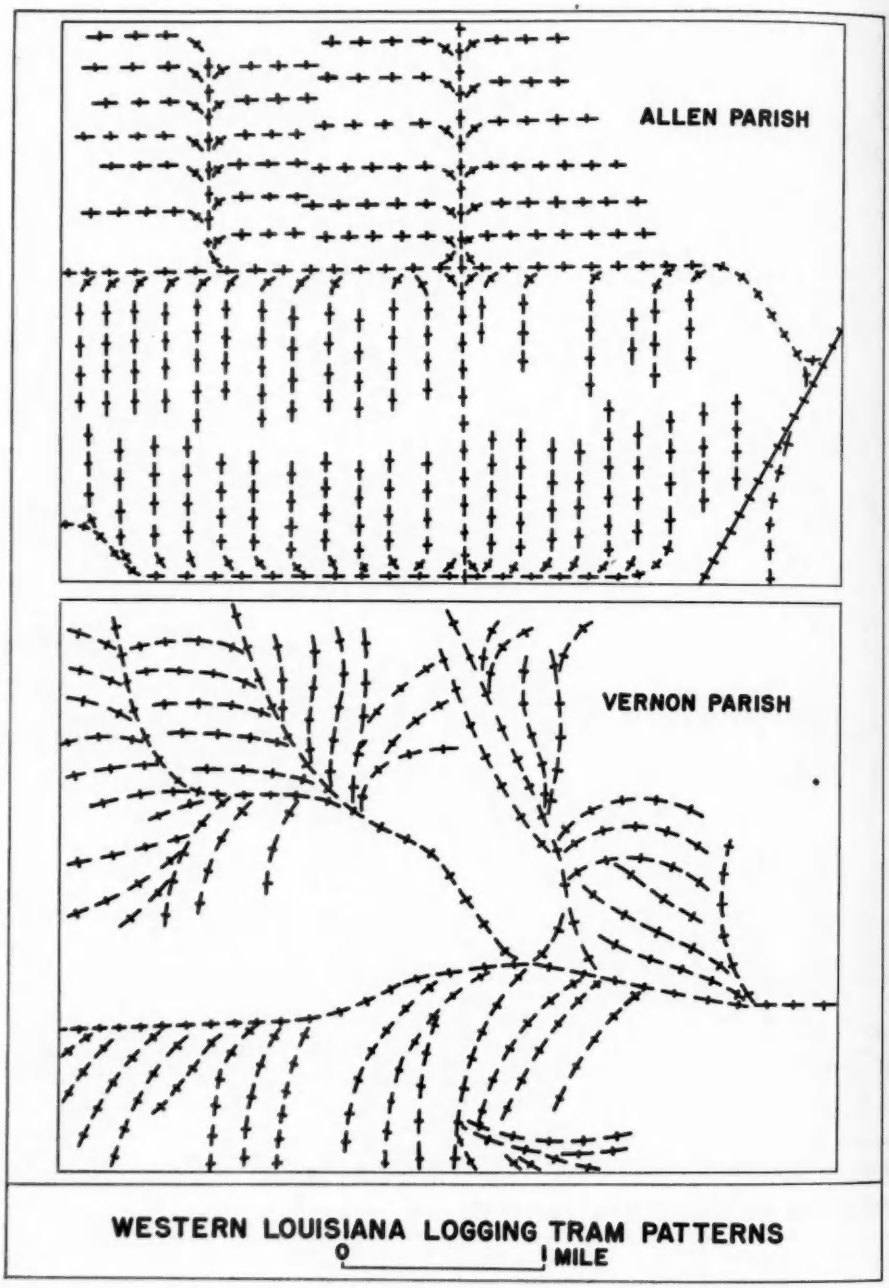

FIG. 10. Examples of contrasting tram patterns which reflect variations in topography. Taken from aerial photographs.

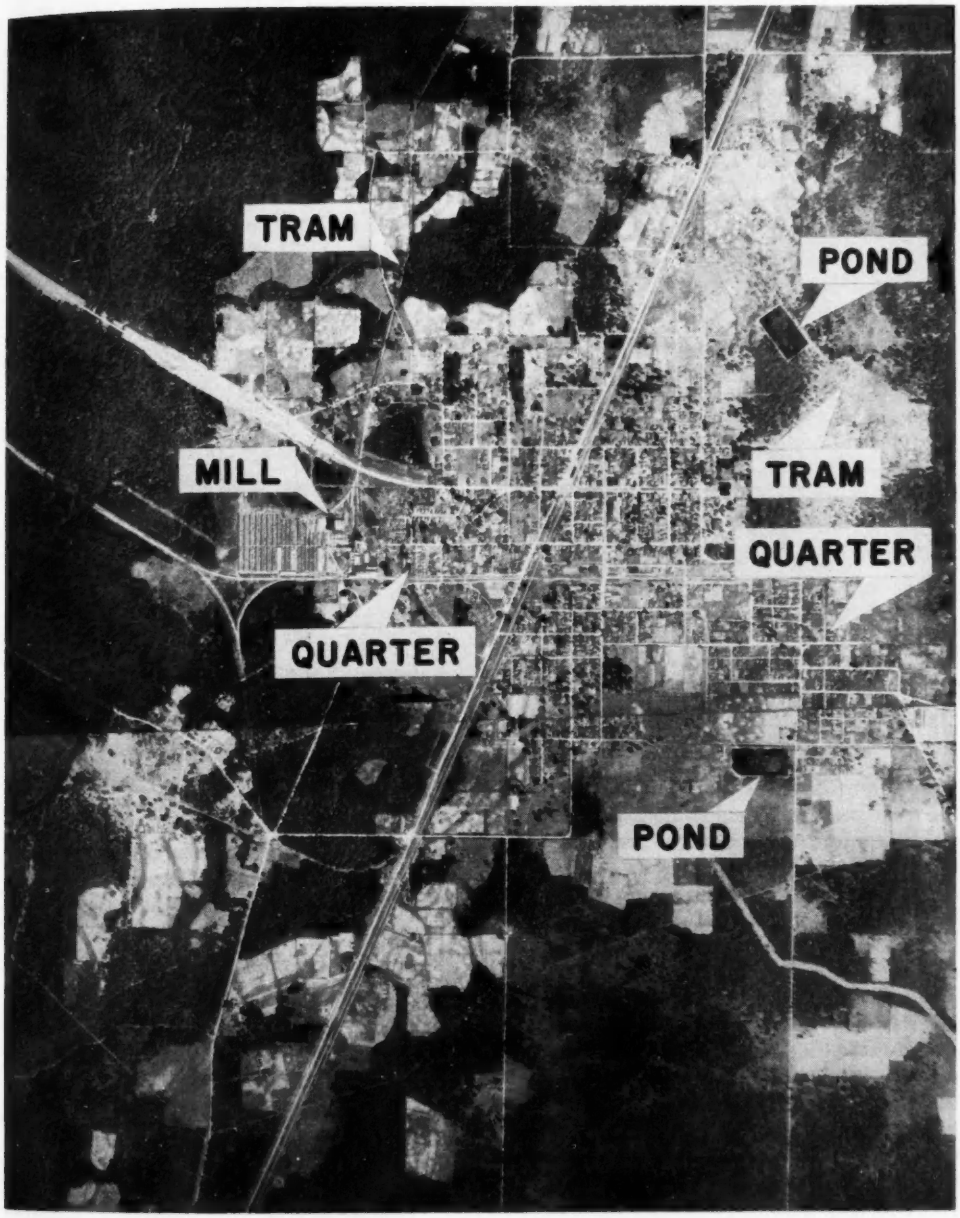

FIG. 11. Aerial photograph of Oakdale, Allen Parish, Louisiana. This picture well illustrates the influence of the lumber industry on western Louisiana towns. Oakdale once had five active sawmills. The two abandoned mill ponds in the right of the picture are each about 250 yards long.

other event which might slow operations at the front. Availability of water sometimes determined the locations of towns, and where water supplies were deficient reserve ponds were dug. Water stored there was transferred to the main pond as needed. Most ponds were

made by damming creeks, but some were entirely artificial.

Lumber at the mill was usually moved on "dollies," heavy two-wheeled carts drawn by mules. "Dollyrun" mules were sheltered in barns near the mill, the area around each barn being enclosed by a fence and called a "corral." In some instances mules were eventually replaced by electric or gasoline tractors.

The business district. A section in each company town was devoted to providing the more essential goods and services. A single building —the commissary—was the commercial heart of the community. This was a department store owned and operated by the company, and there the mill employees bought the bulk of the everyday items they consumed. Such stores were superior to anything ordinarily seen in the older towns of the area, and almost everything sold in them was brought in by rail. The commissary building often housed other facilities, and it was not uncommon for the barber, the doctor, the deputy sheriff, and others to occupy offices under the same roof. Occasionally some conveniences and necessities were furnished by neighboring settlements, but this was not the rule.

The company offices were usually situated in a large frame building near the commissary. They often served as banks, and at some sites the large brick and steel vaults alone remain to mark their former positions. A few of the larger towns had branch banks from nearby communities. Boarding houses two or three stories high were prominent features of the commercial district. Many towns had halls where motion pictures were shown several times a week, and almost all had post offices and barber shops. The company doctor maintained a downtown office which served as a drug dispensary. A depot and ice storage house complete the picture of a business district which appears rather attractive in comparison with that of the average small town of the time. Certainly the mill town residents felt that the facilities available to them were superior to those of many older communities.

The quarters. Residential districts usually followed rather similar patterns of orientation and placement. Negro quarters were situated near the mill, as were the less common small sections set aside for Mexican workers. Areas occupied by whites were closer to the business district and were separated from the mill and Negro quarters by some feature—a strip of woods, a railroad, or open fields.

The companies frequently tried to make white residential sections attractive.[20] Trees were planted, streets were graded and graveled, and street lights were installed. The churches and schools for whites were usually located in this part of town. As a rule only one church was built in each section, a "Union" or "Federated" church in which joint services were held. Few cemeteries were opened, since there seems to have been a general understanding that the towns were impermanent. The schools were one or two-story buildings where classes were taught at least as far as the seventh grade. Older children often commuted to high schools in neighboring towns.[21]

The company houses. The dwellings built by the lumber companies were remarkable for the uniformity of their construction, and sometimes entire quarters were made up of houses identical in nearly every respect. This is understandable in view of the fact that almost all the buildings were erected before the majority of the population arrived, and limiting the number of house plans simplified construction. Less obvious are the reasons why certain house types were chosen. In some cases advantages are apparent, but in others selection seems to have been dictated by custom or style alone. The choice varied from time to time, and the growth of a residential area can sometimes be traced in the accretion of groups of houses of different types. Whatever the bases of adoption might have been, four plans were popular: the pyramidal, the bungalow, the shotgun, and the log-pen derivative.

Pyramidal houses (Fig. 3), with roofs sloping upward at the same angle from all four sides toward a central point or short ridge, are almost universal in Louisiana.[22] The sawmill variety is distinguished by its rather small dimensions, generally square floor plan, and single story. Its adoption seems to have been

[20] This practice is well described by F. V. Emerson in "The Southern Long-Leaf Pine Belt," *Geographical Review*, Vol. 7 (1919), pp. 81–90.

[21] The general pattern of company town construction outlined above was by no means restricted to western Louisiana. This is shown by G. M. Hudson in "A Study of a Permanent Alabama Lumber Town," *Journal of Geography*, Vol. 36 (1937), p. 310.

[22] Kniffen, *op. cit.*, p. 182.

FIG. 12. Bungalows in a Negro quarter at Leesville, Vernon Parish, Louisiana.

purely a matter of style, and many informants called it the "sawmill house." The bungalow (Fig. 4) was two rooms wide and two or more rooms deep, with gables facing front and rear. Bungalows are more easily constructed than pyramidal houses, are cheaper, and lend themselves to considerable modification. The shotgun house (Fig. 5) was built in logging camps as well as in the company towns. It was one room wide, two or more rooms deep, and had gables facing front and rear. The house was cheap, easily built, and could be moved by rail, a common practice. The log cabins of the early pine land settlers served as patterns for houses built in some company towns. These dwellings (Figs. 6 and 7) had sideward-facing gables and were one or two rooms wide. An extension was usually built at the rear, often in the form of a lean-to. Although the central hall or passage of the original double log-pen was omitted in the larger houses, the resemblance is quite plain.

As a general rule the larger homes were built for white families. Negroes were ordinarily quartered in shotgun or single log-pen houses. Some homes were partitioned so as to shelter two families. All houses were built and rented by the company, but improvements were usually made at the occupant's expense. Company officials often had quite elaborate residences of twelve or even fifteen rooms, but these too tended to conform to company building practice. Many company houses were soundly constructed of the best lumber available and are still in use after 50 years of continuous occupation.

Maps indicating the occurrence of the four basic house types in the twenty sawmill towns studied (Fig. 8) reflect the routes along which they entered western Louisiana. The pyram-

FIG. 13. Residences at DeRidder, Beauregard Parish, Louisiana.

idal house was already popular in states north of Louisiana and was apparently brought in from that direction, since it occurs most frequently in that part of the area. The bungalow was built earlier by south Louisiana farmers[23] and was carried northward as the lumber industry moved up from Lake Charles. The shotgun house was introduced from two directions, one variety being brought in from the north by lumber companies which chose the house for its portability. A slightly different version, borrowed from the French farmers to the south,[24] was carried northward with the bungalow. The log-pen derivatives were already present in the pine lands,[25] and were adopted by some lumber companies, but they were never as popular with the industry as the other three types.

The logging trams. The sawmill was connected with operations at the front by the logging "tram," a precariously-built and impermanent standard-gauge railway. Tram systems were often quite extensive and continued to develop during the entire period of mill operation. The right-of-way was staked out by the logging superintendent, the man primarily responsible for getting logs to the mills. His ability to do this at low cost in great measure determined the margin of profit the company

[23] J. W. Taylor, "Southwest Louisiana—A Culturo-geographic Region," *Cultural Survey of Louisiana* (Louisiana State University: Final Status Report, N 7 ONR 35606, 1951), p. T-17.

[24] *Ibid.*

[25] M. Wright, "The Hill Settlement of Louisiana," *Cultural Survey of Louisiana* (Louisiana State University: Final Status Report, N 7 ONR 35606, 1951), p. W-2.

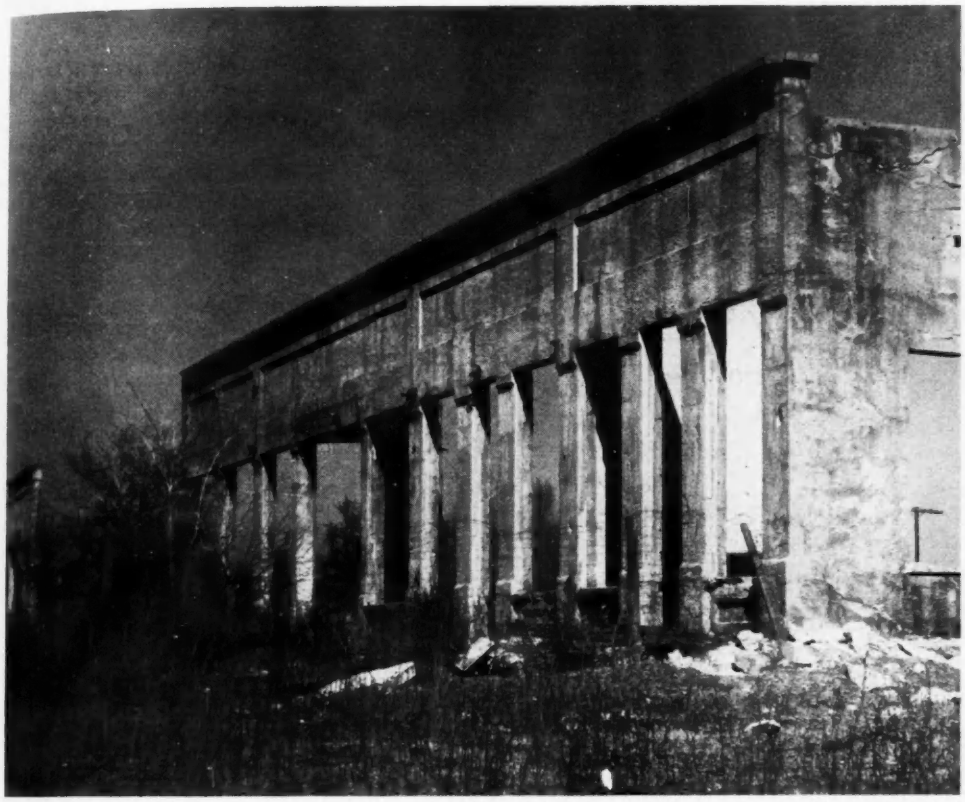

FIG. 14. Ruins of the company commissary at Fullerton, Vernon Parish, Louisiana. This building had concrete floors and walls, and was 90 feet wide and 120 feet long.

made on its lumber. Where terrain permitted, as on the level terrace surfaces in the south, tram patterns tended to be regular. In hill areas, such as Sabine and Vernon parishes, trams conformed to local topography and irregular patterns resulted (Fig. 10).

SURVIVAL OF INTRODUCED LANDSCAPE ELEMENTS

The lumber industry exerted its modifying influence primarily upon the urban centers of western Louisiana, and practically every settlement in the area was changed to some extent. Any town with a sizable sawmill or in which the industry was once active is almost sure to exhibit some characteristics of the company town. Most apparent are the residential quarters (Fig. 11), still occupied even though the companies which built them may have ceased operation thirty years ago. All of the house types described above are represented in considerable numbers, the bungalow (Fig. 12) and pyramidal house retaining the greatest measure of popularity. Many homes in the better residential districts are obviously patterned after the familiar company houses (Fig. 13).

Abandoned company towns constitute an important landscape element, and western Louisiana is dotted with these "ghost" settlements. Many ponds remain to mark former mill sites (Fig. 11). Some have been drained, but others serve as recreational spots or as watering places for the growing herds of livestock. Mill foundations and the ruins of buildings (Fig. 14) often reveal town sites, and street patterns are frequently visible in air photos. Old logging trams are found everywhere in the cutover lands, and in many places their rights-of-way still see service as motor roads (Fig. 15).[26]

[26] Emerson, *op. cit.*, p. 83.

FIG. 15. Abandoned logging tram near Ward, Allen Parish, Louisiana, now used as a road for logging trucks. Many stretches of track have been improved and incorporated into the permanent road system.

CONCLUDING REMARKS

The longleaf pine district of western Louisiana was almost untouched by loggers before 1895, and the subsequent rapid construction and peopling of numerous large sawmill towns constitutes by far the most extensive cultural invasion the area has ever experienced. The impact of the great mills upon the landscape is revealed in the familiar stretches of cutover land and second-growth forest and in the forms and patterns of human occupance peculiar to the industry. The latter were concentrated in the urban centers of the area and comprise a major portion of the visible record of man's activities there. This study of some of these landscape elements only begins to measure the contribution of lumbering to Louisiana geography, since it does not cover other sections where the industry was similarly active and makes no attempt to determine the extent to which natural landscapes have been modified. Surely, however, it indicates the importance of such inquiries on the part of the geographer and suggests much work for the sociologist and historian.

THE LOCAL-SUPPLY AGRICULTURE OF CALIFORNIA[1]

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San Jose State College

EASTERN markets and the modern California agricultural economy are inseparable. But the California market, especially with the great increase of population in its two major urban nodes during and since World War II, is also becoming important. Only the Middle Atlantic Seaboard surpasses the California population as the largest market within the boundaries of a specialized horticultural area in the United States. Consideration of the California "local-supply" agricultural areas in their orientation toward the two principal state markets, Los Angeles and the San Francisco Bay Area, reveals the fragmented areal pattern of California agriculture much more clearly than is ordinarily presented in studies of the state's agricultural contribution to extra-state markets. Coastal lowlands also assume a greater relative importance than they normally bear to the Central Valley and desert oases on a national production basis. Recent over-all production patterns and trends in California agriculture are reflected in the local-supply picture, however, to a great degree. Finally, the opposing areal demand patterns of the two urban centers furnish several interesting illustrations of the interaction of economic- and physical-geographic factors.

To date, the most comprehensive source of raw statistical data pertaining to California local-supply agriculture is that of the annual unload reports of the Federal-State Market News Service, United States and California Departments of Agriculture.[2] These reports cover the amount of California fresh fruits and vegetables arriving by truck at the principal food markets of Los Angeles, San Francisco, and Oakland. The shipments are categorized according to origin areas within the state. To facilitate comparisons, all produce is reduced to a common mass unit, the "truck unload." Although these features of the reports limit somewhat their validity as an over-all indicator of California market demands on local-supply agricultural areas, it can be said that most of the fruits and vegetables are currently still consumed fresh in California cities and that over 80 to 90 percent of all fresh produce coming to these two urban markets is transported by truck. Origin areas are defined in the unload reports on the basis of county groupings. Fortunately, the boundaries of almost all of the groups run through rough and unproductive terrain, so that it is possible to substitute a more natural regional division and terminology based on landform (therefore, productive) areas.

GENERAL CHARACTERISTICS OF LOCAL-SUPPLY AGRICULTURE

As with all agriculture in the West, distribution patterns in California are highly complex, one of the few unifying factors being their valley orientation. At least 32 valleys regularly contribute some supplies to both the Los Angeles and Bay Area markets. For ease of comparison, several of these valleys may be grouped into units, primarily on the basis of proximity.[3] The resulting list is provided with numbers keying the individual valley and "valley-group" areas to an index map (Fig. 1):

1—North Coastal Range Lowlands (Lower Eel and Mad valleys; Upper Russian River Valley; Clear Lake Basin)

2—San Francisco Bay Area (Santa Clara, Santa Rosa, Sonoma, Napa, Berryessa, San Ramon-Livermore, and Lower Russian River valleys; South Suisun Lowland)

3—Salinas-Pajaro valleys

4—Sacramento Valley

[1] The author gratefully acknowledges the cooperation of Mr. A. M. McDowell of the San Francisco office of the Federal-State Market News Service and Messrs. C. B. Miller and W. B. Shreveland of the Los Angeles office.

[2] Published under varying titles. See footnotes 4–7.

[3] While not usually considered a part of the Los Angeles Lowlands, the Santa Clara Valley of southern California is included in that unit here because statistics for both Ventura and Los Angeles counties are combined in the unload reports. The production of scattered desert lowlands is also added in these reports to that of the Los Angeles Lowlands. The amount of their contribution is relatively small.

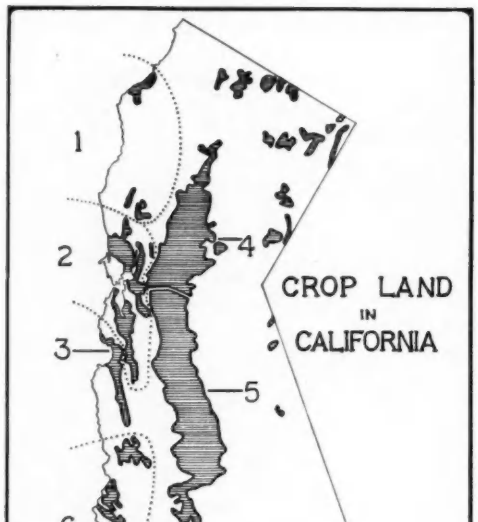


FIG. 1. Distribution of California crop land. Generalized after L. A. Crawford and E. B. Hurd, *Types of Farming in California Analyzed by Enterprises*, University of California, Agricultural Experiment Station Bull. 654, Sept. 1941, Plate I.

5—San Joaquin Valley
6—South Coastal Range Lowlands (Santa Maria, Santa Ynez, and Upper Salinas-Estrella valleys; Santa Barbara Littoral)
7—Los Angeles Lowlands (Los Angeles Basin; San Gabriel, San Fernando, and Santa Clara valleys; San Bernardino and Perris plains; desert lowlands)
8—San Diego Littoral
9—Coachella Valley
10—Imperial Valley
11—Palo Verde Valley

California markets not only continually draw on all of these areas but also purchase freely from both market gardening areas and the larger and more dispersed truck farms of specialty-crop culture (the raising of only one or two fruits or a limited number of vegetables). The specialty-crop farmer usually sells a good part of his produce to out-of-state markets. But if local market prices become more favorable, he may divert a significant part of his production there. The same principle of opportunism may be applied to the market gardener, but in reverse. In many cases, the specialty-crop farmer regularly supplies both state and national markets in large amounts.

The extensive development of truck transport within the state has also enabled expanding California markets to tap specialty-crop areas almost as easily as the closer market gardening districts. Like automobiles, trucks have figured importantly in the very early stages of major urban expansion in the state. Distances in California have thus generally proved less a handicap to transportation of produce than comparable mileages in earlier-developed sections elsewhere. The Los Angeles area, for example, received 75 percent of its fresh fruits and vegetables by truck as early as 1934.[4] This increased to a record 88 percent in 1952. Comparable statistics in that year for the New York, Chicago, and Philadelphia produce markets were 33, 24, and 52 percent, respectively.[5] Even area-cramped San Francisco, still bound more closely economically to the railroad than Los Angeles, obtained over 80 percent of its fresh produce by truck in 1955.[6]

Another interesting comparison between California and eastern United States lies in the annual poleward progression of peak production as the warm season advances.[7] Such an areal shift of production for California markets is much more generalized than that of the humid East. A primary reason for this is the reversal in California of the poleward increase in population density characteristic of the East.

[4] United States and California Departments of Agriculture, Federal-State Market News Service, *1936 Annual Unload Summary, Fruits and Vegetables* (Los Angeles, 1937), p. 2.

[5] Federal-State Market News Service, *Unloads of Fresh Fruits and Vegetables at Los Angeles, 1952* (Los Angeles, 1953), Preface.

[6] Federal-State Market News Service, *San Francisco: Unloads of Fresh Fruits and Vegetables, 1955* (San Francisco, 1956), p. ii.

[7] As described by D. W. Whittlesey in "Major Agricultural Regions of the World," *Annals*, Association of American Geographers, Vol XXVI (1936), pp. 199-240.

TABLE 1.—TRUCK UNLOADS AT LOS ANGELES, 1936–54[1]

Origin[2]	1936	1940	1943	1950	1954
Los Angeles Lowlands	34,814	41,699	30,335	38,161	43,773
San Joaquin Valley	6,403	11,280	9,245	12,390	15,547
San Diego Littoral	1,770	2,224	1,494	6,818	8,551
South Coastal Range Lowlands	4,821	5,646	4,676	7,424	6,617
Imperial Valley	4,616	4,785	4,655	6,115	5,563
Coachella Valley	1,161	1,899	1,651	3,241	4,898
Salinas-Pajaro valleys	1,121	1,835	1,835	2,717	3,637
Palo Verde Valley	—	—	170	1,501	1,685
San Francisco Bay Area	694	640	668	1,438	1,294
Sacramento Valley	374	406	200	457	571
North Coastal Range Lowlands	90	80	170	331	517
Total	55,864	57,494	54,999	80,593	91,652

[1] Computed from unload reports of the Federal-State Market News Service in Los Angeles.

[2] The erratic and small production areas of the Owens Valley and several lowlands in the Klamath and Cascade mountains have been omitted.

TABLE 2.—TRUCK UNLOADS AT SAN FRANCISCO-OAKLAND, 1934–54[1]

Origin[2]	1934	1940	1943	1950	1954
San Francisco Bay Area	6,379	6,271	8,144	8,874	8,467
San Joaquin Valley	4,126	5,552	7,784	6,816	8,018
Salinas-Pajaro valleys	1,457	1,623	2,346	2,289	2,442
Los Angeles Lowlands	805	1,640	2,387	2,965	2,404
Imperial Valley	141	672	961	2,026	1,671
Coachella Valley	21	187	343	781	982
Sacramento Valley	616	446	740	678	654
South Coastal Range Lowlands	290	573	556	794	545
San Diego Littoral	38	199	285	459	544
Palo Verde Valley	—	—	14	174	502
North Coastal Range Lowlands	47	80	218	145	223
Total	13,920	17,243	23,778	26,001	26,452

[1] Computed from unload reports of the Federal-State Market News Service in San Francisco. Statistics for 1934 and 1940 available only for San Francisco.

[2] The erratic and small production areas of the Owens Valley and the Tule Lake region have been omitted.

The densest populations of California are thus in the areas of *longest* growing season. Other obstacles to the development of a shift pattern in California as sharp as that of the East are the relatively smaller population of the state, the highly restricted and fragmentary pattern of population distribution and agricultural land, and the smaller latitudinal restrictions on agricultural production (i.e., areal specialization).[8]

Equally intriguing, but more vital, has been the characteristic of rapid and massive production increases by California local-supply agriculture. The last twenty-year period, with the World War II and postwar influxes of population into the state and the accompanying increase in food demands, illustrates best this quality of great growth (Tables 1 and 2).[9]

[8] Two examples of the complexity of production-shift patterns in California may be noted. Tomato supply centers for the San Francisco Bay Region show in the spring both northward (Imperial Valley to the Bay Area) and coastal (Imperial Valley to the San Diego area) migrations of peak production. However, the more southern Los Angeles area and the more northern San Joaquin Valley each contribute about half of the Bay Area demand for oranges in the same season.

[9] The annual unload reports for the Los Angeles and Bay areas are available for much of this time span. Statistics from only a few of these annual reports are noted here: in part, because of the need for simplification; in part, because of the difficulty in obtaining past reports covering the two urban areas for the same year. The most valid period for a comparative study of the produce demands of the Los Angeles and Bay Area markets commences with 1942, when Oakland first began its reporting service. However, some significant conclusions may also be drawn from the more incomplete statistics of previous years, notably for Los Angeles.

Both the Los Angeles and San Francisco conurbations about doubled their fresh fruit and vegetable demands in this period. Only during World War II was there an interruption to this increase, particularly in the Los Angeles area. Removal of the major group of vegetable growers in California—the Japanese—exodus of consumers from the state into the armed forces, and possibly reduced wastage on the part of the consumer due to higher retail prices were among the principal causes. On the other hand, this momentary diminishment of fresh produce production was not quite as severe as the statistics of the Market News Service would seem to indicate. Some of the more salient reasons were a diversion of more shipment of food supplies to the railroads due to the shortage of trucks and gasoline, the increasing of the weight of the average truck load so as to conserve transportation, the rise of home "victory gardens," and the inauguration of processing of otherwise fresh-shipped produce by government order.

Most of this increase in California agricultural production for its own needs has involved no areal expansion. Intensiveness, long a characteristic of agriculture in the state, is being increasingly emphasized under pressures of market demands and competing land uses. As an example, total vegetable production for California for the period from 1937–39 to 1952–54 increased 48 percent while vegetable acreage increased only about 12 percent.[10] It is also conceivable that acreage expansion for California's food requirements might even be less in the future, despite its swiftly rising population. Obstacles to this areal growth would not be so much the physical problems of rough terrain or lack of water, but rather the competition of out-of-state markets with local demands. Much more of California's produce is sent to the East than to its own markets. Also, some California crops possess natural monopolies, or near monopolies, on Eastern markets. It is therefore doubtful whether the state would ever abandon such a profitable orientation of its agricultural production in favor of an economy of strict local-supply, no matter how pressing her own population requirements. Further intensification thus seems to be the only ultimate solution for the ever-increasing demands of the California population on the agriculture of the state. In this light, it is interesting to note that while the Los Angeles area has lost more agricultural land to urban and industrial use than any other section of California, it also leads all state areas in the expansion of agricultural production for its own needs. The phenomenon of intensification overcoming an increasing deficit of agricultural acreage occurs on a smaller scale in parts of the Bay Area and the San Diego Littoral.

While both the Los Angeles and the San Francisco Bay area markets now draw the bulk of their fresh produce from other sections of the state, each of the two local-supply areas still leads all of its "satellite" suppliers in individual production (Tables 1 and 2). However, a smaller amount of productive land has restricted the Bay Area in its production as compared with Los Angeles. The Bay Region satisfied not quite a third of its market demands in 1954, while the Los Angeles Lowlands supplied practically half of its own market requirements. The national importance of the Los Angeles Lowlands as an agricultural center has been reflected in its general outranking of all areas, excepting the San Joaquin Valley, as a supplier of fresh fruits and vegetables to the Bay Area as well. Another instance of where high national rank in agricultural production is evidenced in local-supply production statistics is that of the Coachella and Imperial valleys. Both sections send more fresh produce to the Bay Area than the much closer and larger Sacramento Valley. Advantages of a highly specialized economy and a somewhat more favorable physical environment in the southern valleys appear to be major reasons.

MARKETS AND SUPPLY AREAS

The Los Angeles Market.—A more detailed picture of local-supply production trends and the two major California markets can also be obtained from further analysis of the Federal-State Market News Service annual reports (Tables 3 and 4). All areas supplying Los Angeles with fresh produce increased their offerings over the 1943–54 period, although this increase is by no means distributed equally among the different local-supply regions (Figs. 2-A and 2-B). The Los Angeles Lowland was the only supply area to show a production increase which was nearly as impressive as its total production. Its gain was twice that of the

[10] Ralph I. Crane, "California Vegetable Industry," *California Agriculture*, Vol. X (May 1956), p. 2.

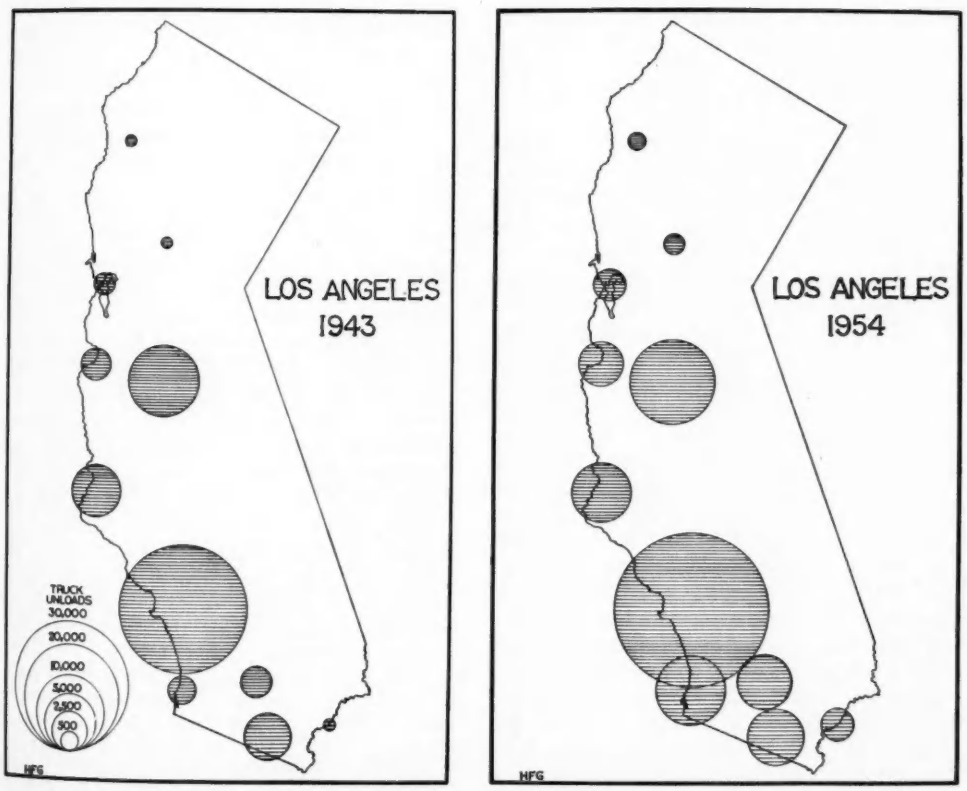
TABLE 3.—CHANGES IN TRUCK UNLOAD RECEIPTS FOR LOS ANGELES, 1943–54

Origin	Increase	
	Absolute	Percentage
Los Angeles Lowlands	13,438	44
San Diego Littoral	7,057	705
San Joaquin Valley	5,302	57
Coachella Valley	3,247	196
South Coastal Range Lowlands	1,941	42
Salinas-Pajaro valleys	1,802	99
Imperial Valley	1,688	43
Palo Verde Valley	1,515	890
San Francisco Bay Area	768	98
Sacramento Valley	371	186
North Coastal Range Lowlands	347	204

TABLE 4.—CHANGES IN TRUCK UNLOAD RECEIPTS FOR SAN FRANCISCO-OAKLAND, 1943–54

Origin	Increase	
	Absolute	Percentage
Imperial Valley	710	105
Coachella Valley	639	252
Palo Verde Valley	488	444
San Francisco Bay Area	323	6
San Diego Littoral	259	130
San Joaquin Valley	234	5
Salinas-Pajaro valleys	96	6
Los Angeles Lowlands	17	1
North Coastal Range Lowlands	5	3
South Coastal Range Lowlands	–11	–2
Sacramento Valley	–86	–17

San Diego Littoral, the area of second largest increase. However, the San Diego Littoral, as well as the Coachella, Salinas, and Pajaro valleys, recorded absolute production increases during 1943–54 that even exceed the gains of other areas which surpass them in total production. Thus, the Littoral, while behind the San Joaquin Valley in total production for the Los Angeles market (Table 1), ranked ahead of the Valley in absolute production increase (Table 3). In contrast, the Imperial Valley was exceeded in absolute production



FIGS. 2-A AND 2-B. Local-supply agricultural production for the Los Angeles market, 1943–54.

increase by over half of the regions regularly supplying Los Angeles. That the Imperial Valley also just barely surpasses the much smaller Palo Verde Valley in absolute production increase points up the impressive expansion of irrigated acreage in the Coachella, Palo Verde, and San Diego areas. Increased yields also figure here, especially in the San Diego Littoral. Only three of the eleven local-supply areas for Los Angeles failed to show impressive absolute production gains: the San Francisco Bay Area, Sacramento Valley, and North Coastal Range Lowlands.

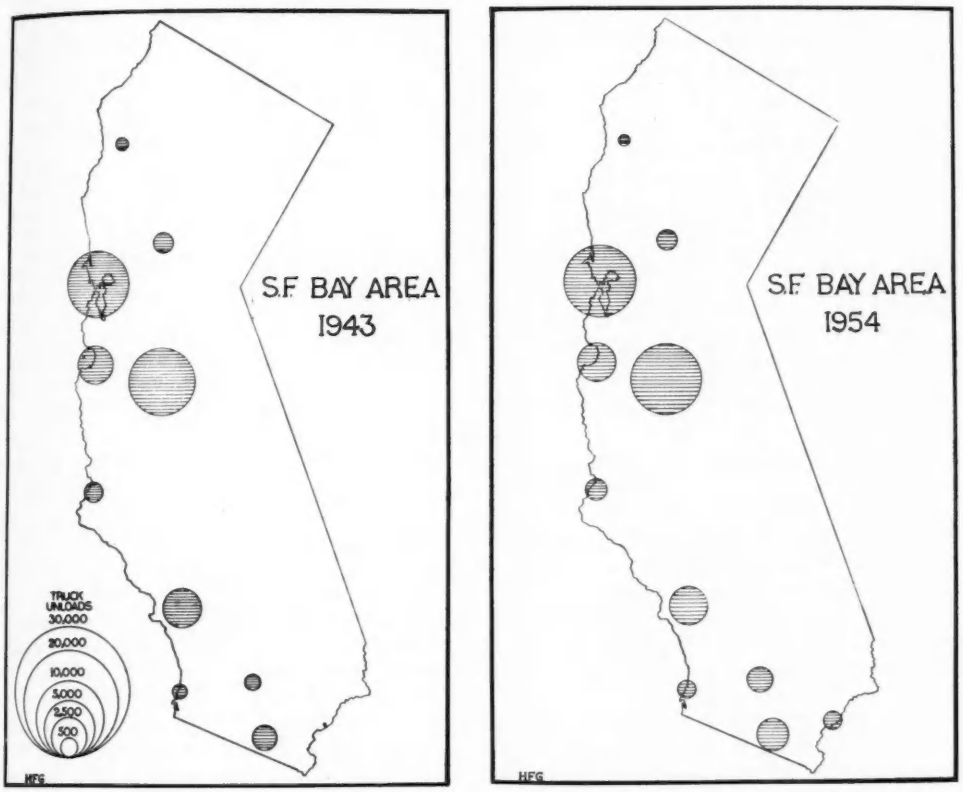
The production increases of the San Diego Littoral and the Palo Verde Valley are especially notable since their *percentage* gains are as significant as their *absolute* expansion. Both areas easily lead all other local-supply regions in percentage increase (Table 3). The Coachella Valley also has evidenced good gains in both percentage and absolute categories. As expected, areas of large total fresh produce production show only small percentage increases (Los Angeles Lowlands and Imperial Valley), while regions of small production display large percentage growth (Sacramento Valley, North Coastal Range Lowlands).

The San Francisco Bay Area Market.—Comparison of trends in the local-supply production for the two big urban markets of California shows several interesting similarities and contrasts. As for Los Angeles, expansion has marked the individual production of Bay Area market supply regions, with the exception of the Northern and Southern Coastal Range Lowlands, Sacramento Valley, and the Los Angeles Lowlands. But no supply source increased its production for the Bay Area market anywhere near as much as for the Los Angeles market from 1943 to 1954. The much greater demands of the larger and more rapidly expanding Los Angeles population are further illustrated by the fact that supply centers lying approximately equidistant between the two principal markets have expanded their production more for Los Angeles. The Southern Coastal Range Lowlands are an excellent example of this, surpassing half of the California local-supply regions in absolute increase of contribution to the Los Angeles market, while ranking next to last with respect to Bay Area demands (cf. Tables 3 and 4). Even the Salinas-Pajaro Valleys, situated almost immediately next to the Bay Area, have a slightly better standing in absolute production increases for Los Angeles than they do for the San Francisco Bay Area market.

Local market orientation does play its bit. Both the San Francisco Bay Area and the Los Angeles Lowlands supply areas have increased very little their production for the other's demands when compared with the increase of the other local-supply areas for the two principal urban markets (cf. Tables 3 and 4). A basic difference between the two local-supply areas, however, is that the Bay Region, despite its low *relative* rank in production increase for the Los Angeles market for the 1943–54 period, practically doubled its shipments to the southern area. In fact, this expansion on the part of the Bay Area was over twice as much for Los Angeles as for itself. The same situation holds for the North Coastal Range Lowlands and the Sacramento Valley. Both regions are far outdistanced by other local-supply areas in increase of fresh fruits and vegetable production for each of the two big demand centers, Los Angeles and the Bay. Yet, both supply regions increased their production for the Los Angeles market by approximately 200 percent, again reflecting the greater over-all demands on all local-supply agricultural areas by the southern center.

Two other significant local-supply agricultural trends may be noted for the Bay Area market: (1) greatly increasing demands on southern California areas, especially the desert regions, and (2) a comparatively much smaller expansion in produce production within the Bay Region itself (Figs. 3-A and 3-B). The Imperial, Coachella, and Palo Verde valleys surpass (in that order) all other supply areas in absolute increase of production for Bay Area demand. That the Bay Area itself falls behind these three regions in production increase for its own needs also stresses the matter of urban encroachment on agricultural lands, a resource problem in the state which many believe to be second only to that of water.[11] All of the desert valleys figure

[11] See "Santa Clara County—Is Agriculture Being Threatened?" *Western Canner and Packer*, Vol. 47 (August 1955), pp. 18–22, and Agricultural Department, Los Angeles County Chamber of Commerce, *1925–54 Crop Acreage Trends for Los Angeles County and Southern California* (Los Angeles: Los Angeles County Board of Supervisors, 1955), 27 pp.



FIGS. 3-A AND 3-B. Local-supply agricultural production for the San Francisco Bay Area market, 1943–54.

more prominently in absolute increases of production for the San Francisco Bay Area market than they do for Los Angeles (cf. Tables 3 and 4). Of the individual areas, the Imperial and Coachella lead, while the Palo Verde is first in percentage increase because of its smaller area. A more interesting difference between the Bay and Los Angeles markets is the greater significance of the Imperial Valley for the former. The Imperial increased its shipments to the Bay market more than any other area, whereas it was surpassed by six other regions in its production expansion for Los Angeles. Such a contrast is largely explained by two other differences: (1) the smaller amount of land being devoted to vegetable production in the Bay Region than in the Los Angeles area and (2) the production of several fruits and vegetables in the Los Angeles area which are best suited physically to both that region and the desert sections (e.g., the Imperial). Contrariwise, the San Diego Littoral shows a more prominent expansionist trend for the Los Angeles market than for Bay Area demands. Here again is shown the powerful attraction of both the larger and closer market, Los Angeles.

Local-supply areas.—Three supply areas furnish the majority of the fresh fruits and vegetables raised in California for its two principal urban nodes: the Los Angeles Lowlands, San Joaquin Valley, and San Francisco Bay Area (Table 5). The Los Angeles area is easily the single most important local-supply area, having dominated the picture for many years. The San Joaquin Valley, while supplying only half as much as the Los Angeles Lowlands in 1954, is a strong second and has maintained that position also for a long period. An equally long, but more tenuous ranking is that of the Bay Area. Its third position is being increasingly threatened by the San Diego Littoral. The over-all production distribution also

TABLE 5.—TRUCK UNLOADS AT LOS ANGELES AND SAN FRANCISCO-OAKLAND, 1934–36—1954[1]

Origin	1934–36	1940	1943	1950	1954
Los Angeles Lowlands	35,619	43,339	32,722	41,126	46,177
San Joaquin Valley	10,529	16,832	17,029	19,206	22,565
San Francisco Bay Area	7,145	7,093	8,927	10,528	10,018
San Diego Littoral	1,911	2,423	1,779	7,277	9,095
Imperial Valley	4,757	5,457	4,836	8,141	7,234
South Coastal Range Lowlands	5,111	6,219	5,232	8,218	7,162
Salinas-Pajaro valleys	2,578	3,458	4,181	5,006	6,079
Coachella Valley	1,182	2,086	1,994	4,022	5,880
Palo Verde Valley	—	—	184	1,675	2,187
Sacramento Valley	990	852	940	1,135	1,225
North Coastal Range Lowlands	137	160	388	476	740
Total	69,959	87,919	78,262	106,810	118,362

[1] Los Angeles statistics are for 1934. San Francisco statistics are for 1936. Oakland statistics commence with 1943.

emphasizes the eccentric areal pattern of economic development in the state: low production in the Sacramento Valley and North Coastal Range Lowlands; medium-to-heavy production in the central portion of the state; heavy production in the southern part. Sixty percent of the fresh produce consumed by both urban agglomerations (Los Angeles, Bay Area) in 1954 came from southern California (excluding the Santa Barbara Littoral).

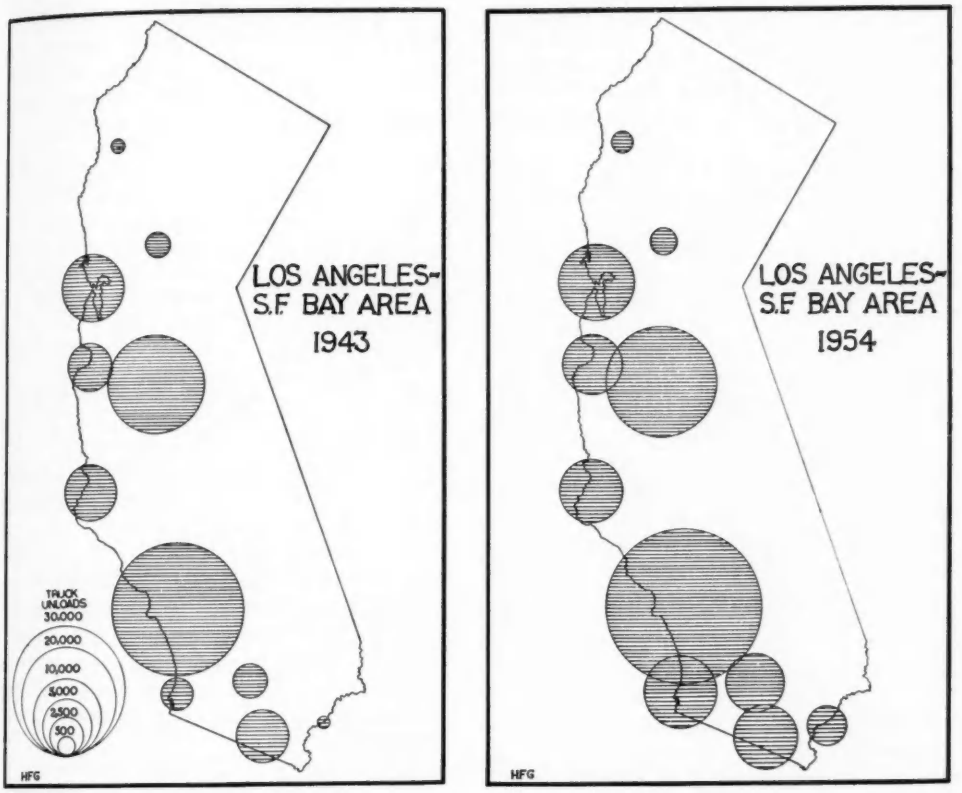
Production trends during the 1943–54 period (Table 6) also emphasize the greater contribution of the southern portion of the state: the southern area already produced 54 percent of the fresh fruits and vegetables absorbed by the Bay and Los Angeles markets during World War II. Second to the Los Angeles Lowlands in production increase is the San Diego Littoral, pointing up the increasing demands for food by the Los Angeles area on its satellite suppliers. The outranking of the San Joaquin by the San Diego area in production increase can be only partly explained by the latter's closer location to Los Angeles. Competition of other urban markets (Central Valley cities) and other crops (e.g., cotton with its price supports) in the San Joaquin Valley has undoubtedly limited to a degree the increase in contribution of that area. The increasingly greater significance of southern California in production of fresh foodstuffs is exemplified by its domination in both absolute and percentage increases for local-supply areas. Five of the first six supply areas in absolute production increase are in southern California, and four of the five in percentage increase likewise lie in that section. In contrast, the San Francisco Bay Area and the Sacramento Valley show both small absolute and percentage increases.

TABLE 6.—CHANGES IN TRUCK UNLOAD RECEIPTS FOR LOS ANGELES AND SAN FRANCISCO-OAKLAND, 1943–54

Origin	Increase	
	Absolute	Percentage
Los Angeles Lowlands	13,455	41
San Diego Littoral	7,316	410
San Joaquin Valley	5,536	32
Coachella Valley	3,886	195
Imperial Valley	2,398	50
Palo Verde Valley	2,003	1,090
South Coastal Range Lowlands	1,930	37
Salinas-Pajaro valleys	1,898	45
San Francisco Bay Area	1,091	12
North Coastal Range Lowlands	352	92
Sacramento Valley	285	29

Another areal development in production trends can be observed: the increasing emphasis on fruit and vegetable production in the drier areas of the state, with its accompanying aggravation of the water problem.[12] The sizable production increases of the San Diego area and the desert oases have been cited. While the San Joaquin Valley has increased its production only moderately percentagewise, it is, as already noted, second only to the Los Angeles Lowlands in absolute increase.

[12] For a more thorough treatment of the relationships between agriculture and the water problem as it applies to southern California, see the author's "The Southern California Water Problem in the Oxnard Area," *Geographical Review*, Vol. XLII (January 1952), pp. 16–36.



FIGS. 4-A AND 4-B. Local-supply agricultural production for the combined Los Angeles and San Francisco Bay Area markets, 1943–54.

Actually, the San Joaquin has equalled the absolute production increase of the Los Angeles area, if the period for comparison is extended back to 1934–36. It is no coincidence that plans for the Feather River Project call for a large portion of this additional water supply to be diverted to the rain-shadow area of the western San Joaquin and to the desert. The heavy produce production of the San Joaquin for local consumption also highlights the small contribution of the more humid Sacramento Valley (Figs. 4-A and 4-B). Only the small supply areas of the North Coastal Range Lowlands produce less, although they, too, have exceeded the Sacramento Valley in production increase for the 1943–54 span.

CONCLUSION

The production rankings of the various agricultural areas of California supplying the state's two major urban markets reflect a combination of four principal agricultural-geographic factors: (1) productive capabilities (size, terrain, soil, water), (2) market distance, (3) market price, and (4) areal specialization. Comparative individual emphases vary, depending upon the particular area. Best illustrating the handicaps of both small area and greater market distances is the North Coastal Range Lowlands supply area. Differences in size and climate are big reasons for the San Joaquin Valley's contributing much more produce to the Bay Area and Los Angeles markets than does the Sacramento Valley. The most favorable version of all four of these factors is offered by the Los Angeles local-supply area, where the location of a large urban market in the midst of an ideal physical environment helps to make it a leader in the production of fresh produce for both California and national

markets. Market price, as a function of the other factors of market distance, productive capabilities, and areal specialization, is particularly important. The contest between national- and local-supply agriculture for arable land in California would appear to be ultimately decided by the relative strengths of state and national market demands, excepting, of course, the artificial effect of political pressures (price supports, subsidies, etc.) upon farmers.

A NOTE ON ROLLIN D. SALISBURY

Rereading of some old writings has brought me back to questions raised by John Leighly in his article on the fate of physical geography.[1]

Rollin D. Salisbury was not a follower of William Morris Davis—anything but. These two rubbed each other the wrong way and clashed occasionally. Each was an outstanding personality in his realm. At almost the same time Davis founded the Association of American Geographers and Salisbury founded the first full-fledged department of geography in an American university.

From Davis' writings it is clear, as Leighly has pointed out, that Davis advocated the development of a science of geography based on cause and effect relationships between natural environment and human life.

From Salisbury's writings and from his remarks to students in the classroom and the field it is clear that he distinguished sharply between physical geography and anthropogeography. As a physical geographer his role was to set the stage on which human life takes place.[2] As for anthropogeography, he left that to others, skeptical but hopeful that a sound basis for study might be found. His personal interest beyond physiography was attracted more to man's influence on nature than to nature's influence on man. For instance, in the field I recall his looking at hummocky marshland and pointing out the influence of cattle in producing this landform—but never anything of what the land had done to the cattle or the people.

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[1] John Leighly, "What Has Happened to Physical Geography," *Annals*, Association of American Geographers, Vol. XLV (1955), 309–18.

[2] For illustration see: R. D. Salisbury and W. C. Alden, *The Geography of Chicago and Its Environs* (Chicago, 1899); R. D. Salisbury and W. W. Atwood, *The Geography of the Region about Devil's Lake and the Dalles of the Wisconsin* (Madison, 1900); R. D. Salisbury and H. H. Barrows, *The Environment of Camp Grant* (Urbana, Ill., 1918).

SEATTLE: REGIONAL CAPITAL OF ALASKA[1]

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IN this paper a general examination is made of the hierarchy of the larger settlements in Alaska. Two anomalies are found: first that Alaska does not have any true regional capital within its own borders, and second that the city which does serve as Alaska's regional capital is Seattle, which lies from 620 to over 2,700 miles away from the Territory. From the other point of view, part of Seattle's hinterland is detached, remote, and over water. This situation finds precedent in the somewhat similar relationships of Marseilles to French North Africa and of Copenhagen to the west coast of Greenland.

SETTLEMENTS IN ALASKA

The total population of Alaska in 1950 amounted to only 128,643, less than that of the least populated state in the United States. The population density was 0.2 persons per square mile in contrast to 1.5 for Nevada, the lowest in the United States, or 50.7 for the country as a whole. This extensive population distribution is not surprising for a "frontier" region or for an area lying for the most part north of 60° north latitude.

Approximately 27 percent of Alaska's total population in 1950 lived in towns with a population exceeding 2,500 in contrast to 64 percent for the United States. Only four towns had populations exceeding 5,000: Anchorage, Fairbanks, Juneau, and Ketchikan. Of these, Anchorage was the largest with 11,254 people. Smaller settlements are more characteristic of the Territory, as Table 1 demonstrates.

The spacing of settlements in Alaska is highly irregular except for the general tendency to locate on a waterway, on the seacoast, or along

[1] I am indebted to Dr. Edward L. Ullman for the time he has spent discussing this problem with me.

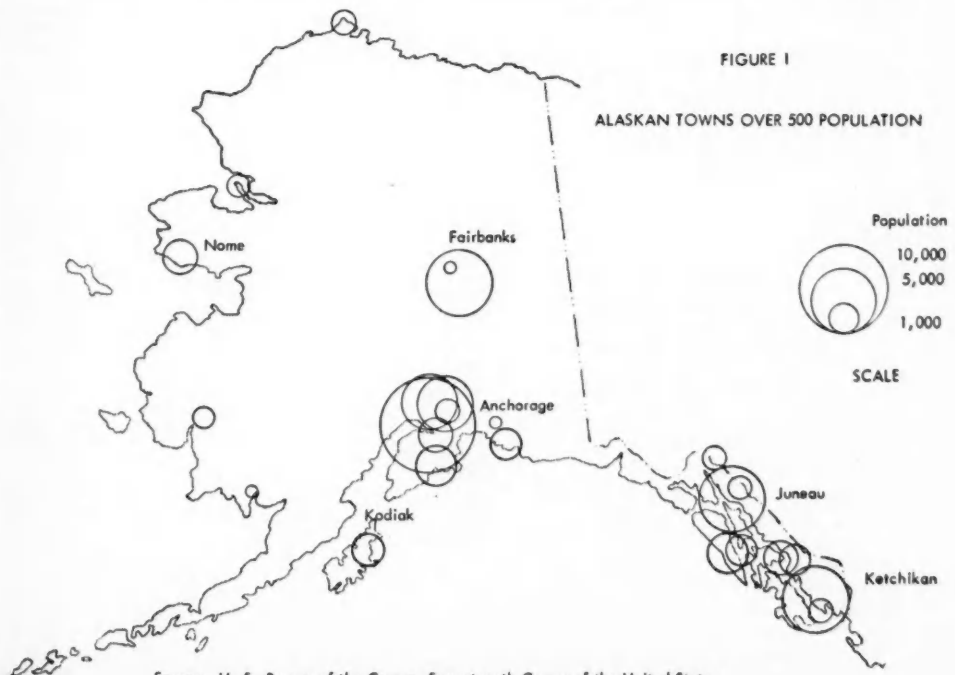


FIGURE 1

ALASKAN TOWNS OVER 500 POPULATION

Source: U. S. Bureau of the Census, Seventeenth Census of the United States: 1950. Population, Vol. I (Washington: Government Printing Office, 1952).

TABLE 1.—NUMBER OF ALASKAN SETTLEMENTS BY POPULATION SIZE IN 1950[1]

Population	Number of settlements
Over 5,000	4
5,000 to 1,000	11
1,000 to 500	12
500 to 100	119
100 to 25	140

[1] *Source:* U.S. Bureau of the Census, *Seventeenth Census of the United States: 1950. Population*, Vol. I (Washington: Government Printing Office, 1952).

a railroad. As several urban geographers have observed, regularity in the distribution of settlements is not to be expected in areas where the chief economic support of the population is mining.[2] Similarly, it would seem that little regularity can be expected in areas where income is derived from fur-gathering, servicing military needs (including construction), or fishing, these being the three activities in addition to mining upon which Alaska's income is chiefly based. A uniformly productive agricultural region is the most likely to produce regularly spaced settlements, but agriculture is insignificant in Alaska.

The larger towns in Alaska exist almost solely to serve their hinterlands as central places, as can be seen in Table 2, which shows the major occupation groups of employed persons in 1950. Most of the occupations listed are performed outside the towns or are performed primarily for the benefit of persons outside the towns. Manufacturing, accounting for only about 9 percent of the Territory's employment, is composed largely of non-urban activities, such as logging, sawmills, and shipbuilding. Much of the remaining activity is categorized as "Food and kindred products" and "Printing, publishing, and allied indus-

[2] Chauncy D. Harris and Edward L. Ullman, "The Nature of Cities," *Annals*, American Academy of Political and Social Science, Vol. XXIV (1945), pp. 7-17; and John E. Brush, "The Hierarchy of Central Places in Southwestern Wisconsin," *Geographical Review*, Vol. XLIII (1953), pp. 380–402.

TABLE 2.—MAJOR OCCUPATION GROUPS OF EMPLOYED PERSONS IN ALASKA AND THE UNITED STATES, 1950[1]

Occupation group	Alaska			United States
		Number	Percent	Percent
Total, all employed persons		43,362	100.0	100.0
Agriculture, forestry, and fisheries		5,626	13.3	12.4
Agriculture	512			
Hunting and trapping	1,899			
Forestry and fisheries	3,215			
Mining		1,337	3.2	1.7
Construction		5,637	13.3	6.1
Manufacturing		3,957	9.3	25.9
Logging	252			
Sawmills, planing mills, and mill work	339			
Ship and boat building and repairing	159			
Food and kindred products	2,196			
Printing, publishing, and allied industries	274			
Other	737			
Transportation, communication, and other public utilities		5,413	12.7	7.8
Wholesale and retail trade		5,430	12.8	18.8
Wholesale	468			
Retail	4,962			
Finance, insurance, and real estate		540	1.3	3.4
Business and repair services		708	1.7	2.5
Personal services		1,720	4.1	6.2
Entertainment and recreation services		351	.8	1.0
Professional and related services		3,052	7.2	8.3
Public administration		7,192	17.0	4.4
Industry not reported		1,399	3.3	1.5

[1] *Source:* U.S. Bureau of the Census, *Seventeenth Census of the United States: 1950. Population*, Vol. II (Washington: Government Printing Office, 1952).

tries," urban in character but again for the benefit of the hinterland workers and not for export from the Territory.[3]

An analysis of shipments from Alaska to the United States again leaves little doubt that Alaskan settlements are not manufacturing centers. For example, in 1946, minerals, fish, and furs accounted for over 92 percent by value of the Territory's exports to the United States.

THE LARGER URBAN SETTLEMENTS

There are three main areas of population concentration in the Territory: Anchorage, the "Panhandle" area (Ketchikan north to Juneau and Skagway), and Fairbanks. Anchorage clearly holds the top urban position for southern coastal Alaska, and within a short distance there is a substantial number of smaller towns and settlements. In the Panhandle two towns vie for the dominant position, Juneau and Ketchikan, and nearby are numerous smaller settlements. These settlements are not joined to one another by any overland means, air and water being the only connections. Apparently this lack of easy communication has been one factor permitting the second and fourth largest towns in the Territory, so closely alike in size, to grow up so closely together in space; the large salmon catch regularly landed in the area is another important factor. Fairbanks is, without contest, the ranking central place for interior Alaska and has the largest hinterland area of any town in the Territory. Two subcenters are located on the coast, Nome and Kodiak, the former oriented toward Fairbanks and the latter toward Anchorage.

Airline schedules (Fig. 2) indicate the importance of Fairbanks and Anchorage as central places, but show Juneau and Ketchikan as relatively unimportant in this context, a reflection presumably of their rather limited hinterlands.

Airline routes themselves impart some useful information to a study of central places in Alaska, but a traffic flow map would probably yield more meaningful information. As Green

[3] The "census week" was during April, 1950, and consequently the summer salmon-canning activities were not included. Military personnel also were not included in these figures, but in present-day Alaska their significance in the Alaskan economy must not be underestimated.

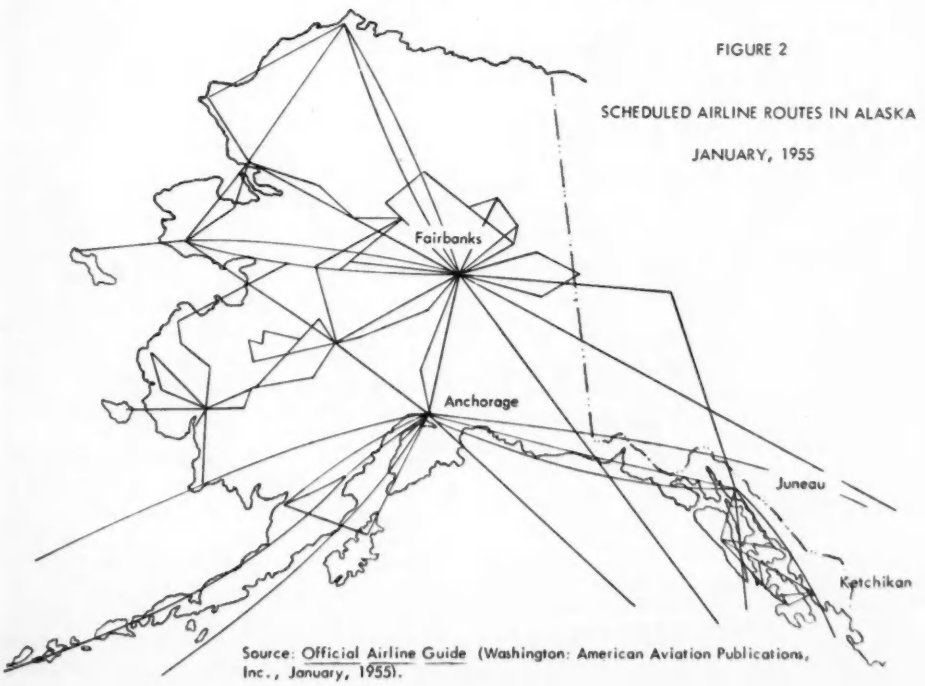


FIGURE 2

SCHEDULED AIRLINE ROUTES IN ALASKA

JANUARY, 1955

Source: Official Airline Guide (Washington: American Aviation Publications, Inc., January, 1955).

used bus services to delimit urban hinterlands in England and Wales,[4] it may well be possible to achieve similar results in Alaska by using airline services. The airplane in Alaska, with so little competition from other transport media, may well approach the significance and usefulness that a bus has in rural England.

Another measure of some interest is the value of per capita retail sales of each of the four main towns (the total value of retail sales of the town divided by the total population of the town). It is assumed that the value of the average annual purchases of individuals living within the four towns does not vary significantly, and therefore the variation in the per capita sales value reflects a greater or lesser amount of sales to persons living *outside* the town. Thus in effect, if our assumptions are true, we have a crude measure of the importance to the towns of the hinterlands served by each of the four places. We find, however, that the cost of living, or at least the cost of groceries, varies from town to town; adjusting for this, using figures for grocery costs released by the Agricultural Experiment Station in Palmer,[5] we arrive at the values shown in Table 3. Crude as these values are, they do indicate that the hinterland sales of the two Panhandle towns are proportionately and markedly smaller than the hinterland sales of Anchorage and Fairbanks.

The hierarchy of central places in Alaska proper leads to two observations. First, although there are four towns showing central place characteristics for various parts of Alaska, there is no single town that shows any evidence of being *the* central place for the territory as a *whole*. Difficulties of transportation in a rather harsh environment and a very large area with a low population density understandably inhibit the possibilities for development of such a single central place. Second, there is no town in Alaska large enough to support the specialized functions that a regional capital must have. No one area in Alaska has been rich enough for long enough to permit the growth of a large city.

[4] F. W. H. Green, "Urban Hinterlands in England and Wales; an Analysis of Bus Services," *Geographical Journal*, Vol. CXVI (1950) pp. 64–88.

[5] The Alaska Agricultural Experiment Station, *Press Release* (Palmer, Alaska, October 20, 1954).

TABLE 3.—PER CAPITA RETAIL SALES OF ALASKAN TOWNS OVER 5,000 POPULATION[1]

Town	Adjusted per capita sales[2]
Fairbanks	$1,900
Anchorage	1,850
Juneau	1,113
Ketchikan	1,270

[1] *Source:* U.S. Bureau of the Census, *United States Census of Business* (Washington: Government Printing Office, 1948); U.S. Bureau of the Census, *Seventeenth Census of the United States: 1950. Population*, Vol. I (Washington: Government Printing Office, 1952); Alaska Agricultural Experiment Station, *Press Release* (Palmer, Alaska, October 20, 1954).

[2] Based on retail sales of 1948, populations of 1950, and adjusted for the cost of living of 1954.

AN EXOTIC REGIONAL CAPITAL

Before proceeding it would be well to stop for a moment to consider exactly what we mean by "regional capital." Obviously, if grocery distribution is being considered, Alaska has hundreds of small capitals, each with a surrounding region; if atomic power plants are of interest the whole world may have no more than two or three capitals and as many regions. But a regional capital is not here defined on the basis of particular commodities or services. Rather it is defined as the smallest central place which serves every part of a region already delimited on some other basis—in this case the political territory of Alaska. Actually Juneau is the smallest center serving all of Alaska in one sense, but its sole function is that of territorial administration, whereas Seattle is the smallest city serving all of Alaska in innumerable ways, from higher education and specialized medical services to wholesaling and publishing. Hence both Juneau and Seattle might be considered regional capitals; the difference is only one of degree, but it is nevertheless a very considerable difference. In terms of general service to the whole region of Alaska, Seattle must be considered as the regional capital.

Historically Seattle has always been the "jumping off" place for Americans going to Alaska. Located in the corner of the United States closest to the Territory, with an excellent port, and at the southern end of the inside waterway to Alaska, Seattle has quite naturally assumed metropolitan functions for Alaska as well as for its contiguous domestic hinterland. Both Seattle and Alaska have been fully

cognizant of this relationship. The Seattle Chamber of Commerce, for instance, has maintained for many years an Alaskan Division, and the *Alaska Almanac's* pictorial section on cities of Alaska includes Seattle and devotes more pages to it than to any town in the Territory except Anchorage.[6]

To verify somewhat more precisely this concept of Seattle as the regional capital of Alaska, several measures are available to us. The most striking one is the analysis of passenger flow as measured by airline seating capacity. An indication of the routes actually taken by passengers between any point in the United States and any point in Alaska, and between any of the four principal towns in Alaska, is given in Fig. 3 for a winter month and in Fig. 4 for a summer month. The number of flights made per week was obtained from the *Official Airline Guide,*[7] and by this means the regularly scheduled airline seating capacity over the period of one month could be calculated.[8] The resulting maps do not indicate the actual volume of passenger flow, but, assuming equal passenger load factors, they do show the relative volume of passenger travel over the various routes.[9]

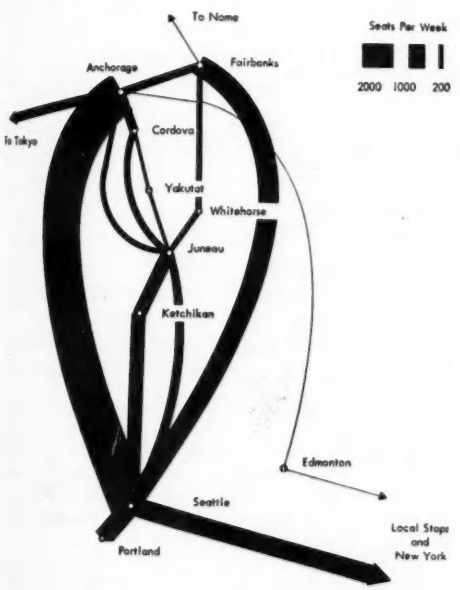
Other means of transportation in Alaska are sharply limited. In the summer of 1954, competing passenger steamship service was offered by one United States company operating from Seattle to Alaska, but William J. Stanton found that during a four-month period in the summer of 1952, 83.5 percent of the business

[6] William Tewkesbury, ed., *Alaska Almanac* (Seattle and Anchorage: Tewkesbury Publishers, 1950), pp. 252–402. This almanac is prepared and edited by Alaskans and presents the Alaskan viewpoint.

[7] Washington: American Aviation Publications, Inc., August, 1954, and January, 1955.

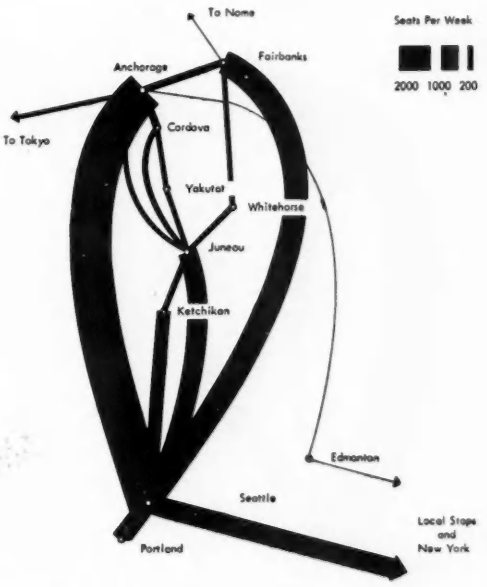
[8] The type of airplane was considered and the seating capacity, which varies from company to company and from tourist to first-class travel.

[9] All regularly scheduled airline movement between the United States and Alaska was through Seattle except for a few flights of the Northwest Orient Airlines which connected Minneapolis with Alaska.



Source: Official Airline Guide (Washington: American Aviation Publications, Inc., January, 1955).

FIG. 3. U.S. Scheduled Airlines weekly seating capacity between the United States and Alaska, and local operations between Ketchikan, Juneau, Anchorage, and Fairbanks, for January, 1955.



Source: Official Airline Guide (Washington: American Aviation Publications, Inc., August, 1954).

FIG. 4. U.S. Scheduled airlines weekly seating capacity between the United States and Alaska, and local operations between Ketchikan, Juneau, Anchorage, and Fairbanks, for August, 1954.

visitors to Alaska traveled by air.[10] By January 1955, passenger steamship service between the United States and Alaska had been completely discontinued, and all passenger travel between Alaska and the United States was by air, except for a small volume on the Alaska Highway and on Canadian steamers serving only the Panhandle south to Vancouver, British Columbia. On the route between Anchorage and Fairbanks the Alaska Railroad offers competition; automobile roads also connect these two towns, although by a circuitous route.

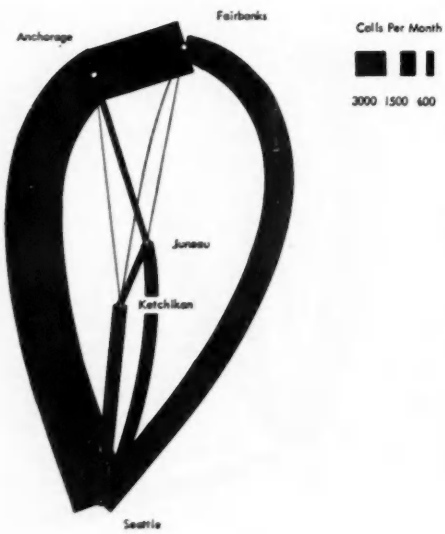
The total picture of intercity passenger movement is therefore quite clearly shown by the airline movements, and it can be seen that each of the four principal towns in Alaska is tied more strongly to Seattle than to any other point in Alaska.

A third map (Fig. 5) plots the number of telephone calls made during an average month between Seattle, Fairbanks, Anchorage, Juneau, and Ketchikan. The Department of the Army, which operates the telephone system in Alaska, does not release figures for specified months but for a recent "average month . . . other than from May to September."[11] Again it is seen that each of the Alaskan towns is more strongly tied to Seattle than to any other in Alaska except for the traffic between Fairbanks and Anchorage, which is considerably stronger than that indicated by the airline map. This exception is due to the fact that large military operations are concentrated around each of the two towns and that Alaskan headquarters for both the Army and the Air Force are located near Anchorage.

It is far more difficult to obtain data concerning freight movement between Alaska and the United States. All regularly scheduled ocean freight service between the two points operates through Seattle, but tramp freighters complicate the picture, particularly in the movement of oil from California to Alaska. However, M. C. Rodman found that in 1929 about 85 percent (by value) of the goods shipped to Alaska, and 69 percent of the goods received from Alaska were handled through Seattle.[12] In 1936 the percentages were 87 and 64, respectively.[13] Unfortunately, figures are not available for recent years. In moving this freight through its port, Seattle is functioning as an entrepôt—a collecting and distributing point—for Alaska, which has no such entrepôt in its own territory. Certainly Alaskan products exported to the United States—gold, fish, furs, and some wood products—are not complementary to Seattle's needs, nor are the manufactured products sent to Alaska manufactured in Seattle to any significant degree.

An analysis of the home residence of students at the University of Alaska at Fairbanks and

[10] William J. Stanton, *Analysis of Passenger Travel to Alaska with Special Reference to Tourists* (Seattle: Bureau of Business Research, University of Washington, 1953), p. 8.



Source: Based on data in a letter from the Alaska Communication System, U. S. Dept. of the Army, April 12, 1955.

FIG. 5. Number of telephone calls during an average month between Fairbanks, Anchorage, Juneau, Ketchikan and Seattle.

[11] This information was contained in a letter from Col. M. R. Kunitz, United States Department of the Army, Alaska Communication System, April 12, 1955. A month other than from May to September was specified to avoid a biased sample resulting from the large number of transient summertime workers from Seattle.

[12] M. C. Rodman, "The Trend of Alaskan Commerce Through the Port of Seattle," unpublished Master's thesis, University of Washington, Seattle, 1930, pp. 33, 44.

[13] Calculated from United States Department of Commerce, *Quarterly Summary of Foreign Commerce of the United States* (Washington: Government Printing Office, 1936); and Port of Seattle Commission, *Port of Seattle Yearbook 1937*, Seattle, n.d.

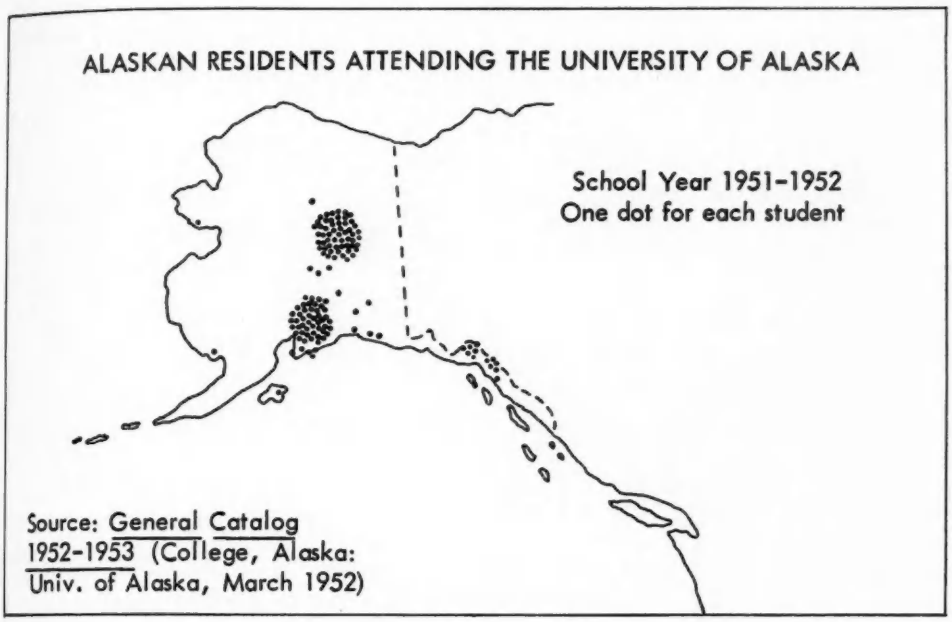


FIGURE 6

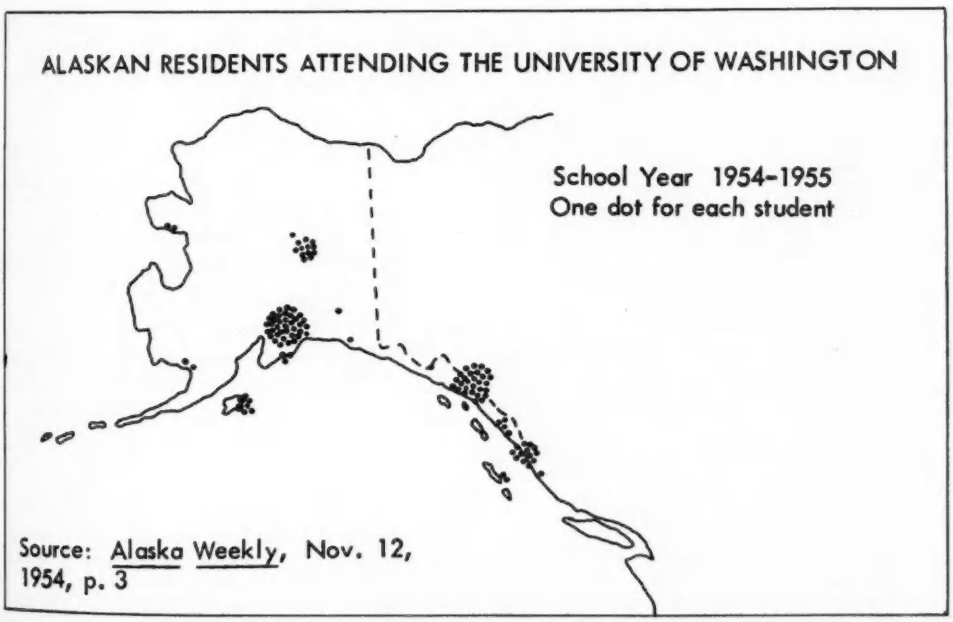


FIGURE 7

the University of Washington at Seattle reveals something about the regional "pulling power" of these two institutions. Figure 6 shows that the University of Alaska attracts students primarily from close at hand—Fairbanks itself and Anchorage—with only a very few coming from the Panhandle area. On the other hand, the University of Washington, which attracts students from the closer Panhandle area, also attracts a large number from Anchorage and even Fairbanks, despite the fact that it is cheaper to fly to Fairbanks than to Seattle from any of the larger towns in Alaska except Ketchikan. It seems safe to say that the University of Alaska serves students from only a part of the Territory, whereas the University of Washington in Seattle is the true center of higher education for all of Alaska.

One final indicator of Seattle's role as regional capital of Alaska can be seen in the ratio of wholesale to retail trade workers. For the United States as a whole, 19 wholesale workers are required to supply 81 retail workers, *i.e.*, 19 percent of all the workers employed in trade are wholesale workers. This might be considered as a standard of centrality. Table 4 compares the percentages for several states. New York state, with a high degree of centrality—that is, with a large wholesale trade serving areas outside New York—requires 23 percent of trade workers in wholesale activities, whereas Nevada, with the least centrality, requires only 11 percent. Alaska's wholesale workers form less than 9 percent of the total number of trade workers, indicating strongly that some place foreign to the Territory handles most of its wholesale activities; and indeed wholesaling is one of the more important functions which Seattle provides for Alaska.

TABLE 4.—PERCENT OF ALL TRADE WORKERS EMPLOYED IN THE WHOLESALE TRADE: COMPARISON OF TEN STATES WITH ALASKA[1]

Region	Percent wholesale workers	Persons per square mile	Population in thousands
U.S. total	19	50.7	150,697
Alaska	9	0.2	129
Nevada	11	1.5	160
New Mexico	14	5.6	681
Montana	15	4.1	591
Arizona	17	6.6	750
Washington	19	35.6	2,379
Massachusetts	19	596.2	4,691
Illinois	19	155.8	8,712
Iowa	21	46.8	2,621
California	21	67.5	10,586
New York	23	309.3	14,830

[1] *Source:* U.S. Bureau of the Census, *Seventeenth Census of the United States: 1950. Population*, Vol. II (Washington: Government Printing Office, 1952).

CONCLUSION

The fact that Alaska's regional capital is located some distance from the Territory itself has both advantages and disadvantages. By sharing its capital with much of the Pacific Northwest, Alaska has access to a much larger city with many more available services than it could otherwise enjoy. Although the distance to Seattle does, of course, result in many inefficiencies and expenses, these are less critical than they might be, for a large percentage of people and freight moving to or away from the Territory must in any case pass through Seattle.

An awareness of Seattle's present function as regional capital of Alaska and of the resulting traffic flow pattern is certainly essential for intelligent consideration of many of the Territory's current problems, including, say, the appropriateness of Juneau as Alaska's political capital or the readiness of the Territory to become a state.

VINCENNES AND FRENCH SETTLEMENT IN THE OLD NORTHWEST

R. LOUIS GENTILCORE[1]

Los Angeles State College

THE most noteworthy achievement of the French colonial system in North America lay in the great distances it covered by efficient use of water routes from the St. Lawrence River westward to the Great Lakes and beyond and southward to the Gulf of Mexico. These same distances proved the main weakness of the colony. The field was too vast for settlement and despite measures frequently adopted by French colonial officials, the growth of population lagged. After nearly a century and a half of occupation, the total white population in the vast stretches of Canada and Louisiana was less than eighty thousand[2] in contrast to the million and a quarter English colonists along the eastern seaboard.

In the Old Northwest numerous posts were established to keep open communication between Canada and Louisiana and to tap the wealth of furs and skins along the routes. None of these proved adequate when seriously challenged as control points by the English in the Seven Years' War. By that time French communication lines were too long to be maintained with any strength. It is not surprising therefore that very few towns worthy of the name grew up under the French in the Northwest. Three may be considered—Detroit, Kaskaskia, and Vincennes (Fig. 1). Each of these shared certain developments common to French settlement in North America. Each was dependent upon trade. Thus a certain kind of location was chosen; a unique form of land occupation was followed and a characteristic type of agriculture developed. Although a good deal has been written about Detroit and the Illinois settlements, not much has been said about Vincennes. It will receive the major emphasis here.

SITUATION AND SITE

Vincennes was one of three posts established along the Wabash-Maumee link in the French system of water transportation.[3] A chief motive in its selection seems to have been the desire to locate near the Miami country to attract the trade of the Indians and gain their support. A village of Piankashaws on the Wabash above the site was brought down to the new post enabling the French to strengthen their frontier and to deprive the English of trade.[4] As the trail from the falls of the Ohio to the Illinois country passed through Vincennes, the settlement soon became a junction point (Fig. 4).

The establishment of the post at Vincennes took place later than that of either Detroit or Kaskaskia. The Detroit site was selected as early as 1701 because of its obvious advantages in the control of the traffic of the upper Lakes at a point where French and British routes into the interior came together. Kaskaskia was established as a mission to the Kaskaskia Indians by the Jesuits in 1703. Along with the other Illinois settlements it slowly attracted traders and later the attention of the Company of the Indies as a source of furs and wheat. The fort at Vincennes was built by 1733 but grew slowly and did not achieve in its early years the prominence of its predecessors.

The immediate site of Vincennes is described by Cutshall as a "gradual terrace, about a mile in width, extending as an irregular tongue-like projection between the river and the eastern sand hills and bluffs."[5] This projection stands out on the generalized soil map as an area of grassland soils. It also represents a position along the river intermediate between the bluffs to the north and the widening flood plain to the south (Fig. 2). The site may also be described as intermediate between that of Detroit and Kaskaskia, the former on the first terrace of the Detroit River, twenty feet or so above stream level; the latter on the bottom land

[1] Formerly at Indiana University. The author gratefully acknowledges financial assistance from the Graduate School Research Fund at that institution for this study.

[2] R. G. Thwaites, *France in America, 1487–1763* (New York, 1905), p. 128.

[3] The other two were the Post of the Miamis, near the present site of Fort Wayne, and Ouiatanon, near present-day Lafayette (Fig. 1).

[4] P. C. Phillips, "Vincennes in Its Relation to French Colonial Policy," *Indiana Magazine of History*, Vol. XVII (1921), p. 328.

[5] Alden Cutshall, "Vincennes, Historic City on the Wabash," *Scientific Monthly*, Vol. 57 (1943), p. 413.

Fig. 1. The Old Northwest under the French.

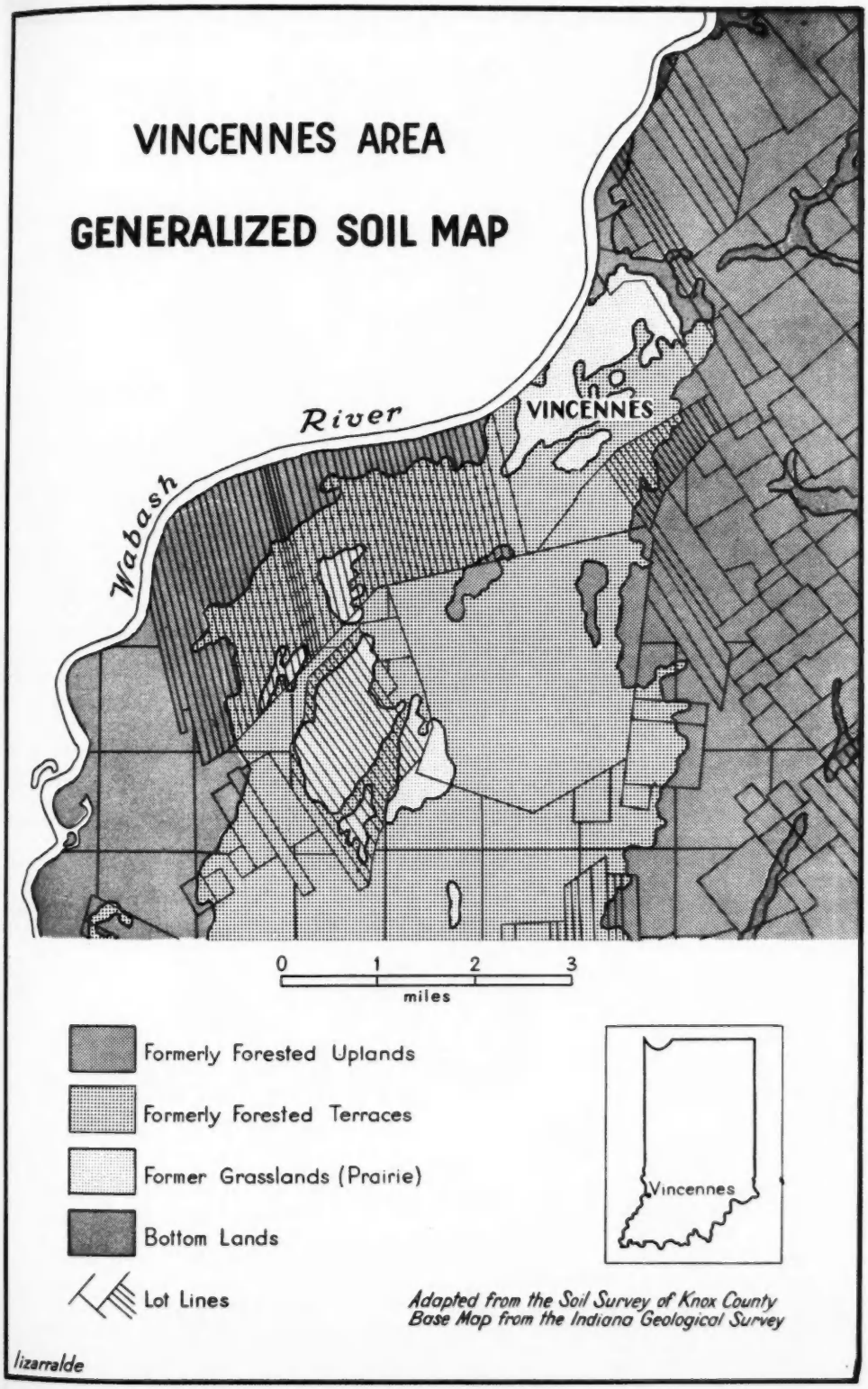


FIG. 2. Generalized soil map of the Vincennes area.

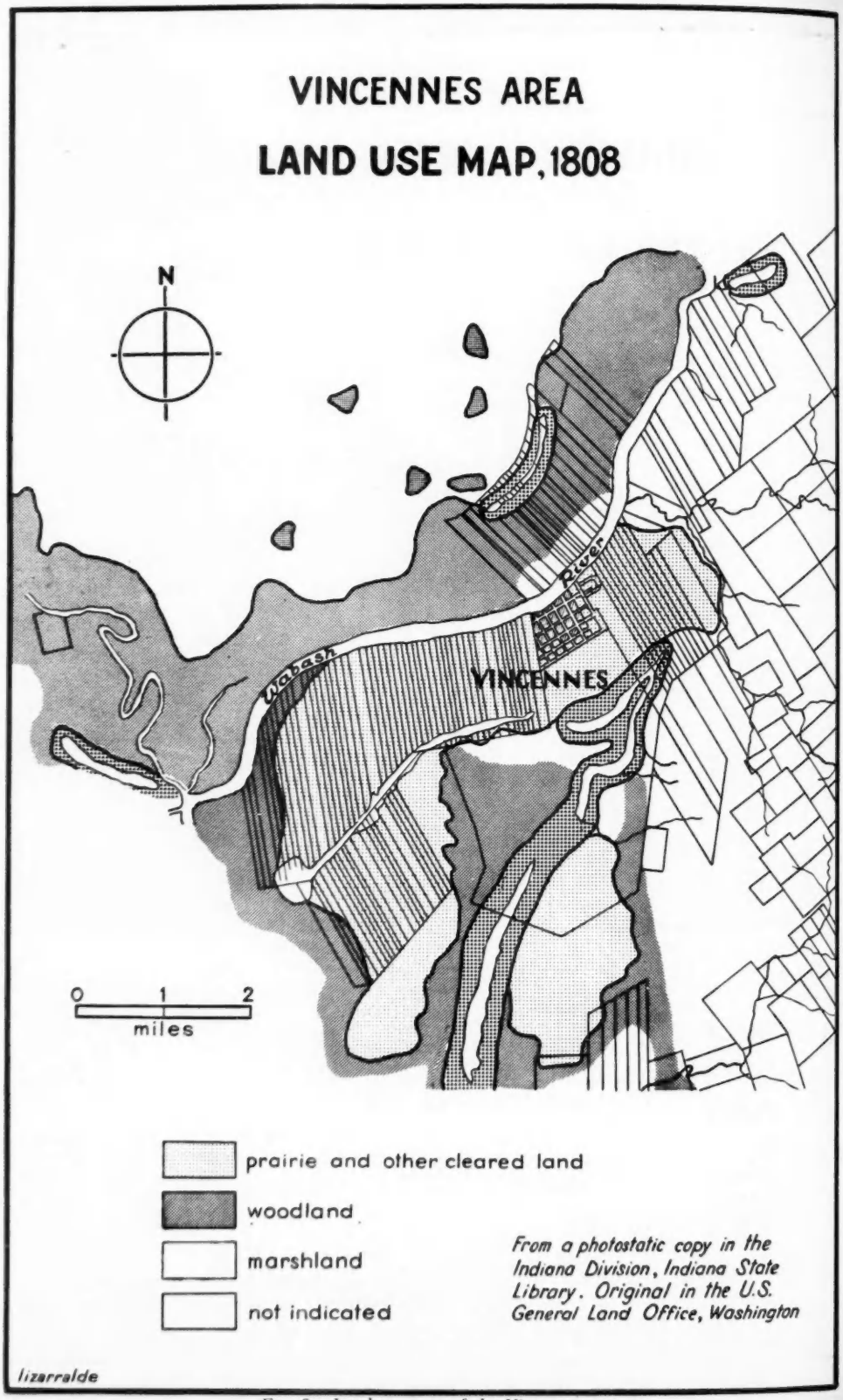


FIG. 3. Land use map of the Vincennes area.

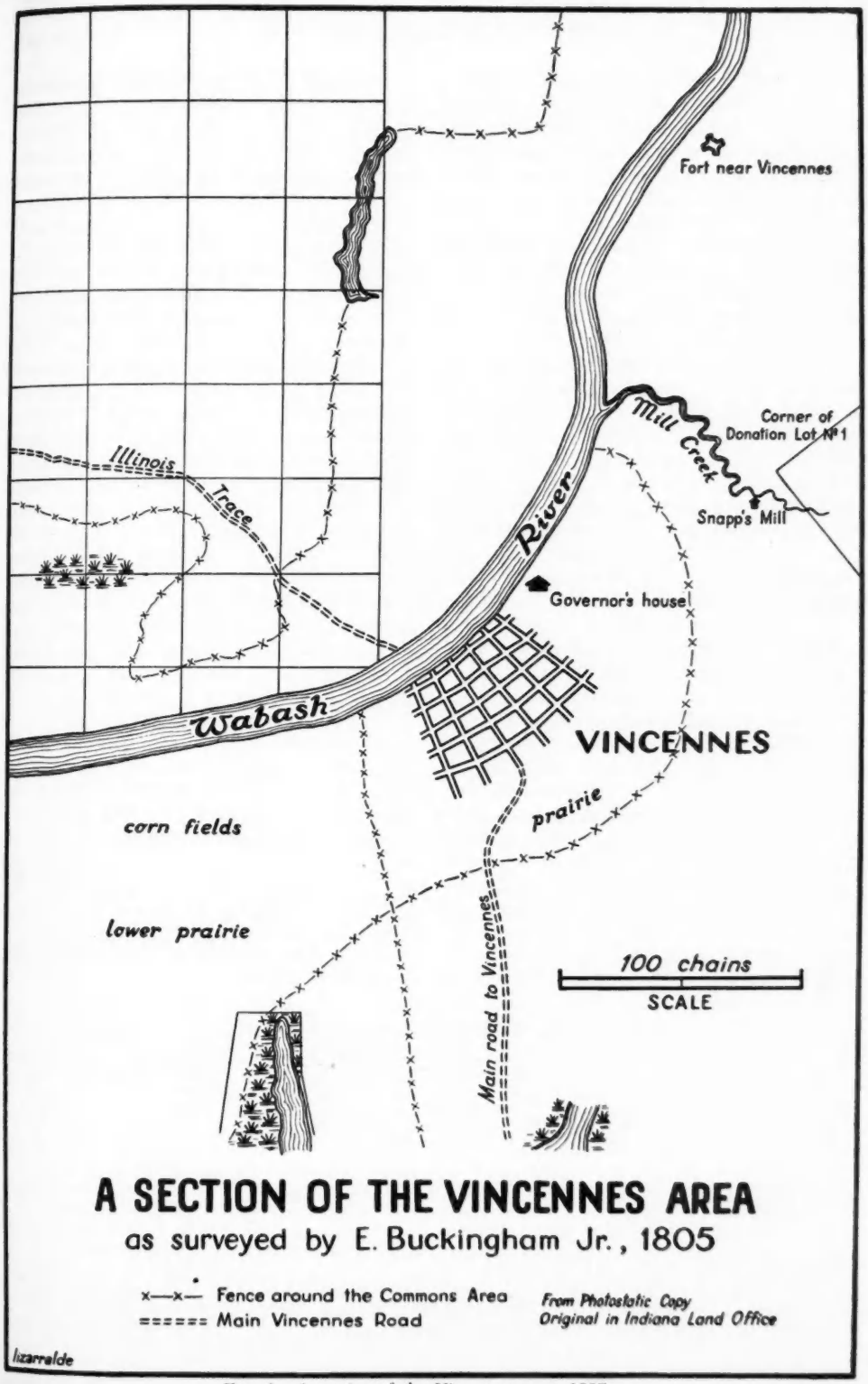


FIG. 4. A section of the Vincennes area, 1805.

between the Mississippi and Kaskaskia rivers.

At both Vincennes and Kaskaskia, the rise and fall of water provided a constant hazard to activity on the flood plain. Hamilton recorded a sounding opposite the Vincennes fort in February, 1779, in which "the depth was found to be 30 feet" compared to "but 10 in the same place . . . in summer."[6] Faux contrasted the high waters of the Wabash when the river was "fine, broad and clear" with its low water stage when "weeds rise from the bottom and grow and rot and impregnate the air with pestilence."[7] Floods were a regular occurrence affecting even the lower parts of the gravel terrace. In 1804, for example, the village was surrounded by water and had to be circumnavigated by the pirogues which unloaded their cargoes on the highest parts of the terrace.[8] Birkbeck found the Vincennes area "unfavorable to health" with "agues and bilious fevers . . . frequent in the autumn."[9]

In common with Kaskaskia and in contrast to Detroit, a good deal of the Vincennes area was in prairie, an aspect noted by numerous travelers and some surveyors. Volney's description is the most complete. "The appearance," he writes, "is an irregular savannah, about eight miles long and nearly three broad, skirted on all sides by eternal forests and sprinkled with a few trees and an abundance of umbelliferous plants three or four feet high."[10] The extent of original prairie as indicated by the soil map would be only a small part of this. Most of the open land was probably the result of regular burning. The "wide-spreading, sky-reddening blaze" that enveloped both prairie and forest preceding a hunt left a vivid impression on all who saw it.[11] Jared Mansfield, writing of the Wabash and the western part of the White River, describes the greater part of the area (the width of the present Knox County) as "generally . . . prairie covered" so that "it will hardly admit of the establishment of permanent boundaries." He describes the vegetation as a "thicket of brush, briers and coarse grass, which when fired, as is the case almost every year, destroys every vestige of wood upon it."[12] Hamilton put the forests "half a league, in some parts a league" from the village and enumerated their most common trees, "Oaks of different sorts, Nutwood, Beech of a great size, Elm, Plane, Ash, Mulberry, Yellowwood, Locust and Leatherwood." He cited the usefulness of the latter both to Indians and hunters for many tasks, including building huts and tying packs.[13]

POPULATION

By means of early reports, corroborated by estimates of travelers, it is possible to form a fairly reliable picture of population in the Vincennes area after the middle of the 18th century. In 1758, Governor Kerlerec of Louisi-

[6] Henry Hamilton's Journal in J. D. Barnhart, *Henry Hamilton and George Rogers Clark in the American Revolution* (Crawfordsville, 1951), p. 175.

[7] William Faux, *Memorable Days in America* (London, 1823), p. 206.

[8] H. S. Cauthorn, *A History of the City of Vincennes* (Terre Haute, 1902), p. 15.

[9] Morris Birkbeck, *Notes on a Journey in America* (Philadelphia, 1902), p. 15.

[10] Constantin F. Volney, *View of the Climate and Soil of the United States* (London, 1804), p. 368.

[11] Faux, *op. cit.*, p. 210.

[12] Clarence E. Carter, ed., *The Territorial Papers of the United States*, Vol. VII (Washington, 1934), p. 224.

[13] Hamilton, *op. cit.*, p. 160.

Table 1.—Population in the Settlements of Vincennes, Kaskaskia, and Detroit[1]

Year	Vincennes	Kaskaskia	Detroit
1710	—	—	200
1722, 1723	—	200	200
1752–1758	100	600	500
1767–1768	400	900	700
1782–1783	143 heads of families	194 heads of families	321 heads of families[2]
1800–1805	714 (town) 819 (neighborhood)	467 (town and township)	550

[1] Figures denote total numbers in the town, unless otherwise indicated. Based on material already cited for Vincennes plus data in Belting, Parkins, Goodrich, Weld, Pittman, Hutchins, Illinois Historical Collection, Michigan Historical Collection, and territorial censuses.

[2] This includes the surrounding area and both sides of the river.

ana reported that there were 18 or 20 habitants besides the 50 men who composed the garrison.[14] The first census under the British (General Gage's report in 1767) listed a total population, including habitants and strangers, of 427.[15] A few years earlier, Croghan noted Vincennes as a "village of about eighty or ninety French families."[16] The movements of Americans into the area, facilitated by Clark's victory at Vincennes, soon caused a rapid rise in numbers. The list of heads of families settled at Vincennes during and before 1783 contains 143 names.[17] In 1787, General Harmar noted "near four hundred houses" in the area and a population of "about nine hundred souls, French, and about four hundred souls, Americans."[18] The first American census, taken in 1801, records a population of 714 in the town and an additional 819 in the "neighborhood of Vincennes."[19]

The following table is an attempt to compare the populations of Vincennes, Kaskaskia and Detroit. At best it is only suggestive of relative numbers. Population figures before 1800 are extremely uncertain and often contradictory. Frequently it is not known if transients, slaves or the garrison are included in the enumeration or if the whole area or simply the population around the fort is indicated. At Detroit the picture is further complicated by settlement on both sides of the river.

Although there is little statistical information to measure the exactness, large numbers of the French apparently left Vincennes in the late 1700's. Austin, in Vincennes in 1797, observed that "not more than three quarters of the Houses are inhabited." He noticed further that, following the American capture, "many of the most respectable and wealthy families left the place and either went to Detroit or to the Spanish side of the Mississippi."[20] Some twenty years later Thomas made a count of the dwellings in Vincennes and listed "eight brick houses, ninety-three frame houses and one hundred and fifty French houses—in all, two hundred and fifty one . . . [but] barns, stables and old uninhabited houses . . . made the whole number about four hundred." In addition he noted "many cellars and old chimney places which lead me to suppose that Vincennes has decreased in the number of buildings."[21]

Alvord discusses the same type of exodus from Kaskaskia, noting a decrease in the French population from 155 heads of families in 1783 to 44 in 1790.[22] Volney, in 1796, wrote that "not a dozen Canadian families are left."[23] The emigrations were a product of the uncertainty of the times. Fear of Indian raids and fear that slaves would be freed by the Americans were exploited by the Spaniards who wished to attract settlers to their side of the Mississippi. The attraction extended to Americans as well. Volney speaks of traveling with migrants from Kentucky bound for the Missouri who told him that "already more than eight hundred Americans were fixed in the country."[24]

Unfortunately, information from written sources is too scanty to permit a detailed account of the internal structure of Vincennes. Belting's description of the houses in Kaskaskia is applicable to those in other French settlements. The French house was the "maison de poteux en terre," constructed of hardwood posts set in the ground, filled in with clay and grass or rubble, stone and clay, plastered inside and outside and whitewashed.[25] Volney noted with pleasure that each house in Vincennes "according to the Canadian custom [was] separate from the rest and surrounded with its court and enclosed with poles . . . and peach trees loaded with fruit."[26] Birkbeck wrote of the town that it "improves in acquaintance, for it contains agreeable people and there is a spirit of cleanliness and even neatness in their houses and manner of living . . . which marks

[14] Phillips, *op. cit.*, p. 335.
[15] J. P. Dunn, *Indiana: A Redemption from Slavery* (Boston and New York, 1905), p. 130.
[16] George Croghan's Journal in R. G. Thwaites, *Early Western Travels*, Vol. I (Cleveland, 1904), p. 141.
[17] American State Papers, *Public Lands*, Vol. I (Washington, 1832), p. 11.
[18] William Henry Smith, ed., *The St. Clair Papers*, Vol. II (Cincinnati, 1882), p. 27.
[19] Carter, *op. cit.*, Vol. II, p. 24.
[20] Moses Austin, "Journal," *American Historical Review*, Vol. V (1899–1900), p. 529.
[21] David Thomas, "Travels through the Western Country in the Summer of 1816," in Harlow Lindley, ed., *Indiana as Seen by Early Travellers* (Indianapolis, 1916), p. 102.
[22] C. W. Alvord, "Introduction," *Collections*, Vol. II, Illinois State Historical Library (Springfield, 1907), p. cxliii.
[23] Volney, *op. cit.*, p. 379.
[24] *Ibid.*, p. 377.
[25] N. M. Belting, *Kaskaskia Under the French Regime* (Urbana, 1948), pp 30–1.
[26] Volney, *op. cit.*, pp. 368–69.

the origin of the settlement in a way which is very flattering to the French."[27] A very different view is expressed by the caustic Faux. He saw Vincennes as "an antique lump of deformity . . . an old worn out dirty village of wooden frame houses, which a fire might improve."[28]

TRADE

Under the French, the chief activity of the inhabitants was the fur trade. The policy of the government was to make the western posts self-supporting by building up their trade. However, limitations were imposed, usually in the form of some licensing arrangement, which restricted trade. As early as 1754, settlers threatened to abandon the Vincennes area because of such restrictions.[29] Thomas Hutchins in 1778 described the Vincennes settlers as dealing "with the natives for furs and for skins to the amount of 5,000 livres annually."[30] His figure for Ouiatanon was 8,000 livres. No comparable figure is available for Kaskaskia but inventories listed by Belting indicate that trade was heavier.[31] Dominating all other posts in the Northwest was Detroit whose trade rivaled that of Quebec City and Montreal soon after it was established. Some indication of relative volume of trade is supplied by the amount of merchandise sold at the posts of Detroit and Ouiatanon in 1761. Its value at the former was 350,000 livres, at the latter, 60,000 livres.[32]

Throughout the French period the currency of the posts was furs. Furs paid for the Indian trading goods and other necessities that came to the posts from the north (via Detroit) and south (New Orleans). Other items were sent along with furs. Hutchins mentions shipments of flour, salt, beef, tallow, and pork regularly sent to New Orleans from the Wabash settlements.[33] The French preoccupation with trade and long journeys was to endure well into the next century and cause astonishment among travelers. "They consider it nothing at all," wrote Heckewelder of the Vincennes population, "to make a journey by water of 300 miles and back again."[34] Volney noted that the French used the expression "going to town" for the trip to New Orleans, "as if they lived in one of its suburbs."[35]

Furs moved to the northern markets following the defeat of the French in 1763 but trade languished during the Revolution and French and Spanish traders from St. Louis once more invaded the Wabash-Mississippi settlements. The capture of Vincennes and Kaskaskia by Clarke further diverted trade to St. Louis.[36] During the years of general peace following 1783 the demand for furs increased slightly but the small trader did not benefit. Furs were brought in by Indians and varied a good deal in quality. Some of the larger merchants did well. A "valuation of peltries" sold by the Montreal firm of Todd and MacGill for Francis Vigo of Vincennes in December 1786 totaled more than £1500. It listed 3,450 deer skins, 726 beaver skins (coarse), 265 raccoon skins, 110 bear and various others (otter, wildcats, foxes.)[37]

The British influence, albeit indirect, continued through the Indian wars of 1789–1795. In a letter to the Secretary of State in May, 1795, General St. Clair blames the British for attempts to "destroy the credit of our traders and alienate the affections of the savages." He cites the case of a large cargo of Indian goods, valued at 50–60,000 livres shipped from Michilmackinac to Vincennes and practically "given away, not sold" to draw trade in that direction.[38] After 1796 British interference was withdrawn from the Wabash route but for the next 20 years trade moved very slowly because of the wars in Europe.

In general, the fur trade was of greatest significance to the Wabash and Mississippi settlements in the period before 1763 and it was then that their trading tradition was established. The general decline that set in after this date was further facilitated by the movement of

[27] Birkbeck, *op. cit.*, p. 119.
[28] Faux, *op. cit.*, p. 20.
[29] Phillips, *op. cit.*, p. 335.
[30] Thomas Hutchins, *A Topographical Description of Virginia, Pennsylvania, Maryland, and North Carolina* (London, 1778), p. 29.
[31] Belting, *op. cit.*, pp. 66–7.
[32] *Michigan Pioneer and Historical Collections*, Vol. XIX (Lansing, 1911), p. 14.
[33] Hutchins, *op. cit.*, p. 374.
[34] John Heckewelder, "Narrative of . . . Journey to the Wabash in 1792," *Pennsylvania Magazine of History and Biography*, Vol. XII (1888), p. 169.
[35] Volney, *op. cit.*, p. 374.
[36] P. C. Phillips, "The Fur Trade in the Maumee Wabash Country," *Indiana University Studies in American History*, Vol. XII, (1925), p. 96.
[37] *Vigo Papers*, in the Library of the Indiana History Society, Indianapolis.
[38] Carter, *op. cit.*, Vol. II, p. 516.

Americans into the area. With them, trading gave way to agriculture.

AGRICULTURE

Even under the French, however, an in contrast to conditions at other posts in the Northwest, agriculture was an important element in the economy of the three posts. Most visitors had something to say about it, if only to point out its shortcomings. At Vincennes, Henry Hamilton saw a variety of physical factors that could promote farming activity—"very extensive meadows [that] supply abundance of pasture for cattle in summer . . . and soil . . . thin and sandy, but black and fertile [and] below this . . . gravel to a considerable depth, so that Wells are readily struck and the water is cool and wholesome."[39] Heckewelder was especially impressed with the site. "Of all that I have seen," he wrote, "it is the finest and most distinguished. The entire county is level, the soil is black sand, the Wabash . . . clear . . . full of fish."[40]

Although the possibilities for agriculture were never fully realized, they did result in a production that was sizable for the haphazard methods involved. Production at the three posts is summarized in Table 2 which is based upon enumerations taken by British authorities. Population figures have also been included to provide some measure of rates of production per capita. In considering rates, it is necessary to keep in mind that probably no more than half of the families tilled land. In the confirmation of the old claims of the French, following American control (1788), it was found that only 60 persons had farms in the prairies around Vincennes but that at least 120 persons had lots in the town.[41]

Following the French Canadian custom, the farm lots were aligned in rows. They were usually two arpents wide and forty deep, although some were four arpents wide.[42] Three prairie areas were occupied by the French, the Upper and Lower Prairies above and below Vincennes, and the Cathlinette Prairie to the southwest. The three are shown on the land use map, Figure 3. A comparison of this map with the modern soil map, Figure 2, indicates a close relationship between the occupied land, especially the two smaller prairies, with prairie soils. The bulk of the Lower Prairie lies on formerly forested terraces that must have been cleared before the land was occupied by the French. These lands were never enclosed but cultivated by the owners in a common field with allowance for rows between adjoining grants to enable cultivation without trespassing.[43] There is little evidence to indicate differences in productivity between the three areas although Heckewelder singles out a "little village to the West [of Vincennes] where the real farmers among the French live."[44]

Hutchins and Pittman were impressed with the variety of production, the former at Vincennes, the latter at Kaskaskia, both noting Indian corn, wheat, tobacco, hops, and a large variety of European fruits.[45] Hamilton noted the same crops but found a good deal to criticize, especially in the matter of cultivation. "Most of the farmers," he wrote of Vincennes, "content themselves with harrowing over old

TABLE 2.—AGRICULTURAL PRODUCTION AT VINCENNES, KASKASKIA, AND DETROIT, 1767, 1782

	Vincennes (1767)[1]	Kaskaskia (1767)[1]	Detroit (1782)[2]
Total population	400	900	2,200
Corn			
Bushels corn (grain) to be reaped	5,450		
Bushels Indian corn to be reaped	5,420	25,500	
Corn			355
Acres under corn			521
Wheat, bushels		13,085	1,804
Bushels sown			4,075
Flour, hundredweights			29,250
Mills, number	3	8	
Livestock, number:			
Cows	588	342	807
Oxen	352	295	413
Horses	200	216	1,112
Hogs	295	912	1,370

[1] From enumerations of Gen. Thomas Gage in *Collections of the Illinois State Historical Library*, Vol. XI (Springfield, 1916), pp. 469–70.

[2] From enumerations of Major de Peyster in *Michigan Pioneer Collections*, Vol. X (Lansing, 1908), pp. 612–13.

[39] Hamilton, *op. cit.*, pp. 159–60.

[40] Heckewelder, *op. cit.*, p. 170.

[41] Leonard Lux, *The Vincennes Donation Lands* (Indianapolis, 1949), p. 449.

[42] *Ibid.*, p. 431. One side of a square arpent equals approximately 66 yards.

[43] Cauthorn, *op. cit.*, p. 20.

[44] Heckewelder, *op. cit.*, p. 170.

[45] Hutchins, *op. cit.*, p. 29; Philip Pittman, *The Present State of European Settlements on the Mississippi* (London, 1770), pp. 97, 98.

stubbles and sow their grain without any other precaution .... They use no manure, even for Tobacco."[46] Before this he had written from Detroit that "great crops are raised by careless and very ignorant farmers" only because "the soil is so good."[47] The discrepancy between the reference to "great crops" and the small figures in the 1782 enumeration can be explained in part by the probable decline in production brought on by British control of the post. At the same time, Hamilton's explanation of "good soils" may be taken as an example of the lengths to which he would go to criticize the French and to take away from them what little credit they deserved for their agricultural accomplishments. Detroit, of course, did not have the suitable conditions of climate, soil and topography present at Vincennes and Kaskaskia. Most significant, perhaps, it lacked the large areas of prairie and bottom land soils possessed by these settlements. The fields had to be won from the dense woodlands on all sides and in spite of more than a hundred years' occupance, most of the forest appeared untouched when Americans moved in after the War of 1812.[48]

CROPS AND LIVESTOCK

In contrast to the settlements of the American pioneers, wheat production was of some significance at all the posts. It was apparently least important at Vincennes. Unfortunately figures are not available. The Gage enumeration includes only grain to be reaped at a time when the wheat harvest may have been over. The figures for Kaskaskia are in line with the reputation of the Illinois country as the granary of Louisiana.[49] In Table 3 crop production per capita at Kaskaskia is compared with that of its county, Randolph, over seventy years later when the first census of agriculture under the Americans was taken. The contrast in wheat production is striking. At the same time, methods of cultivation were crude. In a letter from the Illinois country, the Jesuit Father Vivier wrote that "wheat as a rule yields only from five to eightfold; but it must be observed that the lands are tilled in a very careless manner, and that they have never been manured during the thirty years that they have been cultivated."[50]

Corn, the staple crop of the American frontier, was also the staple at the French posts although here production was considerably less than under the Americans in 1840. At Vincennes more than one traveler characterized the habitant as one who was content to hunt, fish, trade, and grow a little Indian corn and vegetables for his family. There's no doubt about the primacy of corn at Kaskaskia. Father Vivier wrote that "maize . . . grows marvelously; it yields more than a thousandfold; it is the food of domestic cattle, of the slaves, and most of the natives of the country who eat it as a treat." It was because of the corn crop that the Illinois country produced "three times as much food as can be consumed in it."[51] The low figures for Detroit must be set against a probably heavier earlier production, before restrictions began to develop under the British.

Another indication of the relative importance of the grain crop was in the number of mills at each of the settlements (Table 2). Kaskaskia leads with eight. Pittman later described the "great advantage" of location on the Kaskaskia River because of "the facility with which mills for corn and planks may be erected upon it."[52] Three mills are listed for Vincennes but according to Heckewelder there was only one in the area in 1779 (probably the one shown on Fig. 4) and even this had been idle for the previous five years.[53] Mills are not listed in the Detroit enumeration, giving some credence to Weld's observation that "in none of the rivers is there a fall sufficient to turn even a grist mill."[54] Windmills and handmills were used for grinding in all of the settlements.

Livestock numbers were high considering the interior location of the settlements and usually impressed visitors. This was particularly true of Vincennes where numbers were, proportionately, the highest. A comparison of livestock per capita at Vincennes in 1767 with that for Knox County in 1840 (Table 3) points

[46] Hamilton, *op. cit.*, p. 160.
[47] From a letter quoted in C. Goodrich, *The First Michigan Frontier* (Ann Arbor, 1940), p. 93.
[48] *Ibid.*, p. 39.
[49] Belting, *op. cit.*, chap. V.
[50] R. G. Thwaites, ed., *Jesuit Relations*, Vol. LXIX (Cleveland, 1900), p. 219.
[51] *Ibid.*
[52] Pittman, *op. cit.*, p. 85.
[53] Heckewelder, *op. cit.*, p. 170.
[54] Isaac Weld, *Travels through the State of North America* (London, 1799), p. 354.

TABLE 3.—PER CAPITA CROP PRODUCTION AND LIVESTOCK, 1767 AND 1840[1]

	1767	1840
	Kaskaskia	*Randolph County*
Crops, bushels per capita		
Wheat	14.5	7.2
Corn	22.8	37.8
	Vincennes	*Knox County*
Livestock, number per capita		
Cows, oxen	2.4	1.1
Horses	0.5	0.5
Hogs	0.7	3.5

[1] Figures for 1840 based upon data in the *Compendium of the Sixth Census of the United States* (Washington, 1841).

up the large numbers, especially of cattle, kept by the French. The condition of the stock, however, received much criticism, just as it did among the early American settlers. Hamilton pointed out that the "very extensive meadows supply abundance of pasture for cattle in Summer, the hay is sweet and strong, and... cattle could easily be foddered through the winter, but the people are in general too lazy to make sufficient provision."[55] Many cattle were left to graze in the river bottoms all winter where it was not only difficult to find forage but where they were also exposed to the danger of floods. During the winter of 1778, 400 cattle were lost in the Wabash floods. Rising waters always meant a general movement out of the village by farmers in their pirogues to bring in cattle, some as far as 20 miles away.[56]

The cattle were usually left in a large common pasture ground which was enclosed by a fence to protect the cultivated fields. At Kaskaskia, in contrast, the cultivated common field was enclosed and the pasture left open.[57] The Vincennes fence, a section of which is shown in Figure 4, was one of the wonders of the area and drew comment from all visitors, some of whom saw in it convincing indication that the habitant was no farmer. The fence in existence after 1760 was "about two miles in depth and eight miles in front"[58] and enclosed an area "comprehending about 2,400 acres of good land and 300 acres of sunken lands."[59] That a good deal of the area was in ponds and marshland and under trees is borne out by the land use map (Fig. 3).[60]

[55] Hamilton, *op. cit.*, pp. 159–60.
[56] *Ibid.*, p. 175.
[57] Dunn, *op. cit.*, p. 95.
[58] Carter, *op. cit.*, Vol. II, p. 92.
[59] A. S. P. *Public Lands*, Vol. I, p. 10.

ATTITUDE TOWARD LAND

Agricultural accomplishments under the French, even where they might be considered impressive, must be kept in their proper economic setting. The fur trade, not the working of land, was the basis of life. This was reflected in the haphazard and confusing methods used to record land grants. The unravelling of the claims to these grants was to present the newly arrived American officials with a detective task of major proportions.[61]

The French made no attempt to increase their landholdings. Their attitude at Vincennes was typical. It is described in a petition for lands to the U. S. Congress in 1788 where the habitants explained that before the coming of the Americans, they had been "chiefly addicted to the Indian trade [and] overlooked the advantages [to be] derived from the cultivation of lands." Nor did they even consider "dividing among ourselves our fruitful country."[62] In an explanatory Memorial a short time afterwards it was pointed out that while many Americans had claimed land following the Clark conquest "not half a dozen of the French have availed themselves of that opportunity."[63]

A new interest in agriculture and in the land as the economic basis of life seemed to come with American control of the Vincennes area. The trade of the past was gone and French agriculture in its rather disturbed state found encouragement in the activities of the American settlers. The new attitude was expressed in a petition to Congress for donation lands in 1787. "The moment we were connected with the United States," they wrote, "we began to be sensible of the real value of lands; and our

[60] The Commons was recognized as such by an act of Congress in 1791 but 28 years later the trustees of Vincennes in a Memorial to Congress complained that the Commons was wasteland "producing no real benefit to anyone and a great injury to the community at large." (Carter, *op. cit.*, Vol. VIII, p. 373). They recommended that it be surveyed and divided into lots for sale. This was done about 10 years later.
[61] The whole question of the granting of land to the French settlers and the Americans who followed them in the Vincennes area is comprehensively discussed in Lux, *op. cit.*
[62] Carter, *op. cit.*, Vol. II, p. 58.
[63] *Ibid.*, p. 92.

decreasing peltry trade pointed out to us the necessity of applying ourselves to that new kind of industry."[64] In a petition by the American inhabitants two weeks later, the story of their movement into the area is told: ". . . we visited them [the French] and found that their lands were such as answered all our wishes . . . . Our industry became a spur to theirs: from us they learnt the usefulness of husbandry."[65]

The movement of Americans into the Wabash and Mississippi settlements had begun shortly after the Clark conquest, with the return of some of Clark's men to take up land. By 1781, there were well over 100 Americans at Kaskaskia.[66] The number at Vincennes in 1787 was estimated at around 400.[67] Evidently they did not mix readily with the French because of differences in habits, social life, and ideas of government. Volney draws a striking contrast between the two groups—the Americans with their "fair or light brown hair, ruddy complexions, full faces and plumpness of body that announced health and ease" and the French with their "very meagre countenances, a sallow, tawny skin and the whole body as if emaciated with fasting."[68] Heckewelder noted that the Americans in Vincennes "live very well. Their fields are richly covered, their gardens are in the best of order and they dress in cotton and linen, both of which they raise. On the contrary there is hardly one among the French who can dress himself decently—their gardens are in the same condition."[69]

The agriculture the Americans brought with them was characteristic of the pioneer period in the Old Northwest. Briefly it was an agriculture of continuous grain growing with corn and hogs dominant (Table 3). Two examples may suffice to point up the contrast with the agriculture that had prevailed. The Emison family came from Kentucky in 1804 and settled on 400 acres, nine miles north of Vincennes. One of their first tasks was the construction of a grinding mill whose storage capacity was about 100 bushels of grain. They had brought six millstones with them and set up two stands for corn and one for wheat on Mariah Creek. Several hundred bushels of corn and about 25 bushels of wheat could be ground daily. In time the Emison holdings expanded and became a self-contained community with scores of workers and large herds of cattle and swine.[70] Another pioneer family was that of William White and his two brothers who came from Tennessee following the War of 1812. The Whites took up land in the Busseron Prairie of present Busseron township. They were well equipped and had brought with them 70 head of cattle, one hundred sheep, a number of young horses and fowl and two six-horse wagons loaded with supplies and household furniture. They apparently knew the worth of prairie land and a year after their arrival they had plowed, fenced, and planted 200 acres in corn.[71]

But the new agricultural developments were not shared by the French settlers, neither at Vincennes and Kaskaskia where their numbers, as previously noted, rapidly dwindled, nor at Detroit a few years later when the Great Migration of 1814–1819 brought Americans streaming into the area. At both Vincennes and Kaskaskia, the American government had recognized as belonging to the French those lands that they could in any way establish had been granted by the previous French and English governments. They had been given their Commons. A final aid designed specifically for the French, because of their losses in the period of conquest, were donations of 400 acres of land, granted to all heads of families who had resided in the areas in 1783. But the French did not adapt to the agricultural economy. In their poverty and with a hunting and trading tradition behind them, they saw in the grants only a means whereby they could obtain ready cash and leave. And standing by ready to carry out the transfer were land-hungry Americans. Volney notes that some of the Vincennes land was sold to Americans for "less than eight

[64] *Ibid.*, pp. 58, 59.
[65] *Ibid.*, p. 66.
[66] Alvord, *op. cit.*, p. cxxii.
[67] See footnote 18. Lux, *op. cit.*, reprints a list of 50 members of the Vincennes militia for 1790 to indicate that Americans were present in substantial numbers. With one exception, the dates of settlement are 1784–1789.
[68] Volney, *op. cit.*, p. 370.
[69] Heckewelder, *op. cit.*, p. 170.
[70] J. W. Emison, *The Emison Families* (Vincennes, 1954), pp. 47–48. Some of the land is still held by Emisons today and the village of Emison bears testimony to the important part played by the family in the prairie settlement of Knox County.
[71] A. F. White, Biographical Sketches (Indianapolis, 1890), pp. 36–7.

guineas the hundred acres." Other land "of excellent quality sold as early as 1796 at two dollars an acre and I will venture to say that they are now worth ten."[72] Even before congressional confirmation was given to the reports of the land commission the tracts or the promise of them had been sold by the French for very small amounts. "As early as 1807," writes Lux of Vincennes, "it was evident that the French inhabitants for whom the donations were originally intended and to whom they were first confirmed, no longer owned the 400 acre donation tracts granted to them."[73]

It has been pointed out that the complexity of titles that resulted from the French attitude to land was a factor tending to delay settlement by Americans. In Michigan, for example, the Americans were able to find only "thirteen good titles" in the whole southeastern part of the present state and the rest "abounded in defects which must be deemed fatal."[74] At the same time, the donations of land and the willingness of the French to part with them undoubtedly encouraged immigration into Vincennes and the Illinois country at a time when the frontier of settlement had not yet reached the Wabash. Perhaps we can say that herein lies the contribution of the first white settlers in the Old Northwest. From the beginning of the eighteenth century, they had occupied land, albeit in a haphazard way, in advance of settlement. Their mere presence attracted others, some of whom saw the possibilities of the country. And when the possibilities were exploited in a manner foreign to them, the French passed from the picture.

[72] Volney, *op. cit.*, p. 371.
[73] Lux, *op. cit.*, pp. 482–83.
[74] Parkins, *op. cit.*, p. 129. The quotations are from *American State Papers*, Miscellaneous, Vol. I (Washington, 1834), p. 461.

REVIEW ARTICLES

RECENT WORK BY BRITISH ARCHAEOLOGISTS

Near the end of the first quarter of this century American archaeologists were rounding out the first one-hundred years of investigations, scientific and otherwise, into the origins and cultural evolution of the prehistoric occupants of this continent. About the same time, American geographers were successfully establishing regionalism as a core of geography. Since that time, archaeology has gone through a period of intensive accumulation of raw data more amenable to statistical treatment than before. Just now the discipline is emerging into the beginnings of analysis and synthesis. During the same period, geography has dichotomized somewhat into regional and cultural aspects. Since there is little opportunity to synthesize geographic data in a regional conceptual framework, the analytic approach in geography has been confined largely to the systematic and cultural geographers.

While these developments were unfolding in the United States, a quite different pattern was emerging in England. There geography never became oriented toward regionalism, or at least only to a very limited extent was it considered a valid focus for geography. Rather, interest turned to historical geography and to the history of geography. In addition, pre-eminent men pursued cultural studies of the intimate and total relationships between man and his environment. During the third decade of this century, archaeologists in England turned their backs upon the antiquarians' philosophy and sought in the face of the earth an understanding of past events and their relations to the present. The discipline through which they endeavored to render their field intelligible was largely geography.

Not even geographers in England have used the results of geographical studies as have the English archaeologists. Thus, a critical survey of their published works would be of profit to American geographers and archaeologists alike. An examination of the literature within the pale of this interest leaves one immediately overwhelmed. A wealth of books and articles, most of which find their way to the United States, confronts one, but among them three names loom large, Childe, Clark, and Piggott.

V. Gordon Childe is one of the most prolific writers on prehistory and in that vein might be compared with A. L. Kroeber of the United States, with honor to both men. Childe certainly "belongs" to the same "school" of anthropological theory as does Kroeber, that is, cultural determinism. Also, Childe's interests roam as widely but at an even earthier level than do Kroeber's.

J. Grahame D. Clark is Disney Professor of Archaeology in the University of Cambridge. His significant publications list is mountainous. Clark has done more detailed archaeological excavations of Mesolithic sites than any other European archaeologist.

The present Ambercromby Professor of Prehistoric Archaeology in the University of Edinburgh is Stuart Piggott. This chair was created for and occupied by Childe in 1927. A field Piggott has made his own is the Neolithic culture of the British Isles. It is not insignificant that his first field excavations were done under E. C. Curwen, well known to American geographers. Piggott has said that he would like to have his work considered a sequel to the Mesolithic studies of Clark, and such they well seem to be.

It is too large a task for the moment to review all the contributions of these three English archaeologists. Furthermore, it is not necessary to do so to understand their aims. Rather, a number of their works will be mentioned in this essay to support the fabrication of a perspective they represent. As is the case with a mature student in almost any field, the quintessence of his conceptual position will be delineated best in a single volume, and each of these men has written a recent and especially significant monograph.[1] Of these, Clark's will be given greatest attention in this essay. Particular attention also will be given another book by Clark, *Star Carr*, but the remainder of the important contributions of these scholars is listed at the end of this article. The list is by no means exhaustive. The productive record of Childe and Clark is hardly short of remarkable; yet there is no sacrifice at any time of quality.

A critical review of the works of these men generally makes a series of impressions upon the reader, but the most lasting seems to be that they are engaged in a field of research almost untouched in the United States. It is certain that cultural geography and cultural anthropology have much in common; the two approaches generally use many items of material culture as guides to relationships among extinct or living peoples. Both disciplines rely upon physical geography for the setting, the stage upon which the human drama is enacted. Both concede the environment a limiting, conditioning factor and use these adjectives to avoid any taint of determinism. Despite the compatibility of geography and anthropology, no one in the United States actively used the two disciplines as a means to a single end, namely, a fuller realization of man's conditions in the past or, by extension, how the past situations and events have determined the present conditions. In 1932, less than ten years after Carl Sauer had elevated regionalism to the status of a scientific approach to the core of geography in his *Morphology of Landscape*, Sir Cyril Fox wrote the *Personality of Britain*, one of the first comprehensive studies of the effects of geology, soils, climate, flora, and fauna upon the inhabitants of the British Isles. This latter study was not a harbinger of things to come, but rather represents things already on the scene. It included a detailed soil map of Sussex with plotted distribution of Neolithic, Mesolithic, and Bronze Age archaeological

[1] V. G. Childe. *Prehistoric Migrations in Europe*. Instituttet for Sammenlignende Kulturforsking, Oslo: H. Aschehoug and Co., 1950. 249 pp., 183 figures.

J. G. D. Clark. *Prehistoric Europe: The Economic Basis*. New York: Philosophical Library, 1952. 349 pp., 16 plates, 180 figures.

S. Piggott. *The Neolithic Cultures of the British Isles*. New York: Cambridge University Press, 1955. 420 pp., 3 appendices, 12 plates, 64 figures.

sites, which revealed that the Mesolithic sites were confined to sandy areas, Neolithic to chalky, and Bronze Age spread over both. Already the feeling was implicit in nearly all the writings of recognized prehistorians that the purpose of the writing was a description of whole cultures in an all-dimensional environment.

Clark, in his *Mesolithic Settlement of Northern Europe* (1936), wrote, "It was furthermore clear that, divorced from its background of natural history, the archaeological study was too abstracted from reality to have much meaning. My plan has, therefore, been to introduce the reader to the sequence of natural events in Northern Europe, as revealed by modern research and to proceed from this to synthesize the findings of prehistory in the light of an ever-changing environment." Stuart Piggott, in *British Prehistory* (1949), credits Lt. General Pitt-Rivers with having in the 1880's built up the principles that evolved into the modern excavation techniques, the basic premise being "that every possible scrap of detail must be wrung out of the soil." On the other hand, many archaeologists in the United States seem to consider archaeology an intellectual exercise in classification. Childe points out in *Piecing Together The Past* (1956), that "The importance for archaeology of these phenomena that must be studied by other disciplines (botany, zoology, climatology, and geology) has been recognized in the University of London by the creation of a Department of Environmental Archaeology—a precedent followed by other universities in Britain and on the continent." Clark calls this the interdisciplinary approach.

From among the trio Clark must be selected as the major figure who never loses touch with the several factors mentioned by Childe. Clark's *Prehistoric Europe* warrants examination in detail. From it, even better than from Childe's *Prehistoric Migrations* or Piggotts' *Neolithic Cultures*, can be gained some insight into the methodology and results of this "field" theory in archaeogeography. Clark clearly enunciates the theoretical basis of this approach in the following passage from his *Prehistoric Europe*: "The economy of any community may be considered an adjustment to specific physical and biological conditions of certain needs, capacities, aspirations, and values. There are thus two sides to the equation—on the one hand the character of the habitat, itself to a greater or less degree influenced or even conditioned by culture, and on the other the kind of life regarded as appropriate by the community and the resources in the form of knowledge, technical equipment and social organization, available for its realization. The relationship between man and external nature is thus a dynamic one, and the development of culture viewed in its economic aspects is indeed one of man's growing knowledge of and control over forces external to himself. . . . Yet it remains true that the economy of any community at any moment of time is necessarily the product of an adjustment between culture and environing nature."

In the northern hemisphere the most fruitful period for establishing the man-habitat relationships and the impact these had on modern cultures is the time since the last maximum of glacial advance. The succession of climatic and vegetational zones in Europe and North America is roughly the same. Clark has taken the Late Glacial as the point of departure since all the ensuing time has been a continuum of human occupation in Europe. The subject matter of his *Prehistoric Europe* has been the documentation of this period by the various natural sciences available to him. The conclusions reached are monumental to more than just prehistory.

Clark gives factual support to the concept that the main belts of plant formations have shifted northward since the Late Pleistocene—the treeless tundra closest to the ice front followed by the northern coniferous forest, the deciduous summer forest, and, farthest south, the Mediterranean evergreen forest. Shifts of these zones were "determined by climate, in which the principal factor was temperature." The knowledge of vegetational changes is derived largely from pollen analyses and the diagrams evolved for Denmark, North Germany, and Great Britain are in substantial agreement. It is pollen analysis or palynography that gives the sharpest clues to vegetational change. Clark demonstrates neatly that rising post-glacial temperatures increased the rate of invasion of trees in North Europe, with birch following tundra vegetation, pine displacing birch, mixed oak the pine, and oak finally predominating. These changes encompassed a period of about 10,000 years. Concomitant with the vegetational changes man was undergoing a gradual cultural change, with Mesolithic Savagery characterized by plant gathering, hunting, fishing, and fowling, giving way in part to the farming of Neolithic Barbarism and ultimately (in historic times) to urban civilization. When Neolithic man appeared upon the scene, no longer was "climate" solely operative in the alteration of the vegetational assemblage for a given area. The agricultural pursuits of Neolithic farmers demanded selection of the best lands. Since there were no population pressure factors involved, the better lands were utilized, but subsequently, secondary clayey soils were used, and there was no opportunity for denuded forests to recover.

The foregoing grand generalizations become substantiated when the data upon which they are based are seen. Clark, Childe, and Piggott have brilliantly illuminated them and ventilated most of the controversial points, but Clark still remains the best analyst of the relationship among the cultures and the various ecological factors. "Yet the mere concept of geographical expansion should remind us that the spread of more advanced forms of economy was limited to some degree by the character of the climate, soil and vegetation of the several zones into which Europe has been divided by nature." Thus the tundra lands are "impassable bars to the practice of agriculture"; the coniferous forests consisted of unsuitable trees and undergrowth for livestock and poor soils for agriculture. Only the deciduous and evergreen zones offered conditions conducive to the spread of Neolithic agriculture. Few American geographers have been enabled to relate sweeping cultural changes and innovations with such intimate geographic phenomena. Perhaps we still lack the detailed information necessary for establishing such relationships, but the literature is filled with an abundance of regional data that have never been used for anything.

In the Upper Paleolithic times in Europe man was a hunter and gatherer. Clark suggests that these various folk resembled the Barren Ground Eskimo, a group dependent almost wholly upon the caribou for food, clothing, fuel, and shelter. The Upper Paleolithic peoples were well represented in northern Europe until about 8000 B.C. Archaeological evidence shows that the distribution of these peoples is nearly coterminous with the range of *Rangifer arcticus*, the caribou of northern Siberia and Canada. On the other hand, the reindeer of modern North Europe and arctic Siberia is truly a tundra animal. It is most ideally suited to the "park tundra" vegetation, whereas the caribou is a woodland form. The Paleolithic hunters living in the west of Europe were thus largely dependent upon the woodland form.

The succeeding peoples, the Mesolithic hunters of 6000 B.C. or so, "hunted forest animals almost exclusively." At this time present climatic conditions were nearly approximated, although temperature continued to rise for at least another millenium. These peoples often lived around inland bogs, the ecological conditions of which can be interpreted from bones in the middens. Winter-migrant birds are absent, indicating the sites were not used during that season, whereas numerous wading birds, like cranes, mean summer occupation. Since the middens associated with coastal areas reveal winter-type birds, it may be concluded that the coasts were milder areas during the winter than were the areas around the bogs. Low-lying islands offshore of the European Plain were the scenes of extensive fishery activities. Many of the middens are crowded with fish heads, suggesting that the fish were dried and consumed elsewhere.

By the time of the Romans hunting had assumed a role minor to farming and livestock raising. On sites in North Europe dating from near the beginning of the Christian era, wild-animal bones constitute about 2 to 4 percent of the totals. This was not true at earlier times, such as the Bronze Age, when wild forms might total nearly 35 percent. Certainly at the outset of the Neolithic, the hunting pattern was largely unchanged from its typical Mesolithic tradition.

Despite cultivation of plants by Neolithic farmers the gathering of wild plants continued. In fact, the spread of farming created more meadowlands and thus more weeds for useful food. Not to be disregarded are acorns which must have constituted a great source of food. In recent centuries acorns have aided North Europeans in warding off threatened famines.

Clark's chapter entitled "Farming: Clearance and Cultivation" should be required reading for every geographer and cultural anthropologist. Clark has shown how much intimate, detailed information might be gleaned about a culture by simple observations. As an example, the best-known proponents of shifting agriculture, the Danubians, followed the loess soil up the valley.[2] Formerly, it was thought that the Danube offered a relatively treeless corridor for these Neolithic farmers, but again pollen diagrams suggest that open forests prevailed. The farmers depleted the trees from the loessic soils areas, but after abandonment these same areas were reforested. In some spots the process was repeated several times. At first there was land to spare, but as population increased the demand exceeded the reforestation. Heath lands were greater in the Bronze Age, but were already forming in the Neolithic. Over-grazing may have been a contributing factor in this production of open landscapes. Yet, Clark argues, "surely one is dealing with the effects upon human history of an immense ecological change wrought unthinkingly by the neolithic farmers and their livestock." It will be just such analyses that will enable geographers to solve finally the problem of the origin of savanna lands.

Interpreting the past in the light of modern events is just as applicable to the geographer as to the paleontologist. To appreciate thoroughly the nature of shifting slash-and-burn agriculture, one may gain valuable insight by observing the techniques of the European peasants of the past. These moderns no more than harrowed the seeds among the ashes, that is, dragged a pine or fir tree top over the ground. It is reported that burnings increased rye yields from fifteenfold to as much as eightyfold. Actually, it is very difficult to trace the origin and spread of settled agriculture with fixed fields because so much early evidence is obliterated by later activities. Of course, there is no reliable evidence of the use of the plow in Neolithic times in Europe, but the basic agricultural practices that spread into northern Europe during the Neolithic were derived from the Near East. These Mediterranean techniques were based on the plow; so, despite the absence of direct evidence of its use in North Europe in Neolithic times, the ancient ard probably was used there. As used in the Mediterranean, the plow was a device for pulverizing the topsoil by cross plowing. This broke up capillaries in the ground and prevented drying. The technique was quite applicable to the light soils of the temperate zone, but it could not be applied to the heavy clay soils. As soon as the loess areas were occupied and additional areas were needed for the increased population, the heavy moldboard plow made its appearance.

Implements associated with prehistoric agriculture are criteria of the changes taking place in techniques. The curved, jaw-shaped sickle with individual flint teeth, gave way to single crescentic flint sickles and finally to iron sickles and eventually the scythe. The saddle quern survived to near the end of the prehistoric period and as the Romans invaded northward into Europe the large donkey-powered rotary quern developed to a portable version.

Domesticated-animal remains may be taken as a clear indication of geographic change. During the Neolithic and subsequent prehistoric times the pig declined in numbers in temperate Europe whereas the sheep and horse increased. Clark concludes that this ". . . reflects the progress of forest clearance in the primary area of settlement." This is to say that if sheep were of minor importance during the Neolithic yet grew to prominence later, it must mean the decline and reduction of woodland, which in turn would mean that the breakdown of shifting cultivation must have followed. Similarly, the horse declined in number in post-glacial times when forests increased, only to re-

[2] The movements of these peoples have been documented by one of Childe's most comprehensive studies, *The Danube in Prehistory* (1929).

vive as a domesticated species after forest clearance got under way. The horse was reintroduced during the Late Bronze Age.

Minor factors in the evolution of culture in temperate Europe may have far-reaching ultimate effects. An example brought out by Clark is diet and salt. A diet of game-animal food gives people plenty of salt, but as agriculture supplied more plant foods the demand for salt increased. Salt mines of the Neolithic gave way to brine evaporation. It may be argued that salt could always be obtained cheaply by evaporation of sea water. Hence there developed the salt-fish industry of western Iberia and the Dnieper estuary, and, for the same reason, the pork industry of Gaul. Similarly the consumption of sugar in quantity is recent, but honey once supplied the primitive with sweetening as well as the wax needed in the *cire-perdue* method of casting.

An intensive analysis of the settlement pattern of recent man proves to be highly informative to the geographer and anthropologist. It may be pointed out that musts to be considered in any such study of early dwellings would be: local topography, including such factors as surface relief, subsoil, and water supply; climate, especially the amount of sunshine and rain plus prevailing winds for design of roof, walls, and doors; and raw materials available that might impose limitations upon advancement. Probably cultural status might be the most potent factor; hence the economy of prehistoric temperate Europe was not well-enough advanced to have bricks. Again, forest clearance meant organic building materials were replaced by inorganic —wood by stone and earth.

The nature and disposition of a settlement often reflected the economic condition of the culture. While there was plenty of forest with easily worked loess soils, there was virtually no conflict for sites, but, as population increased, need for fixed fields became more urgent and competition resulted. Defensive dispositions also became more evident.

The technology of any given peoples must be an integral part of the interests of cultural geographers, "... since it is through this that early man adjusted his relationship to external nature and so modified his way of life." Technically, the Maglemose (Mesolithic) hunters and fishermen were just about as advanced as the Danubian (Neolithic) farmers: ". . . in the sphere of stone working itself practically every form and every technique available to neolithic man had already been anticipated or even perfected by craftsmen at a food-gathering stage of subsistence." During the Neolithic the increased demand for fine-quality axes was associated with the need for clearing forests for agriculture. Mesolithic man almost everywhere was without axes.

The possible mutually aiding relationship that can exist between geography and archaeology may be illustrated by a single item of material culture, the axe. Without resorting to any speculation, all three of the archaeologists under consideration have shown that the important implement in the hands of man that altered the face of temperate Europe was the axe. When metal came into Europe in the late Bronze Age and to an increased measure in the Iron Age, it was the axe that rapidly utilized the several new materials, whereas flint tools continued to be used for scrapers, awls, and other crude implements. But the presence of the axe clearly means that deforestation is necessary for agriculture, and hence may be seen as another argument for the increased importance of agriculture. Clark points out that in the Mediterranean bronze tools, ornaments, chisels, and saws were found from Iberia to the Near East, yet temperate Europe had in common only the axe as an important implement. "The supreme importance of the axe, which led neolithic communities to undertake deep-mining and to organize large-scale manufacturies, also ensured that when metal became available a substantial proportion should be devoted to the fabrication of this type tool."

Iron development in the Near East lagged behind bronze because of the softness of the former in pre-steel days. Clark and Childe agree that all the modern basic iron tools except scissors and screws were in use by the beginning of the Christian Era. If it might be concluded that iron production in Europe during the Iron Age was inefficient and wasteful, then, Clark maintains, "ecologically the influence of iron was immense, since not only did its production involve the use of charcoal and by its consequence the clearing of woodland, but the iron axe itself was the most efficient agent of deforestation."

It is true that most American archaeologists would agree that "pottery is the handmaiden of archaeology," but Clark devotes but two and one-half pages to the entire subject, and perhaps reflects the differences in attitudes toward the subject matter of the field. The critical development period of temperate Europe is the Mesolithic, when pottery is either absent or insignificant. Childe, a principal authority on mid-European Neolithic, and Piggott, concerned with British Neolithic, are much more committed to the subject of pottery. Clark gives over several pages in *Prehistoric Europe* to a discussion of wooden containers and possible bark containers. Other objects of material culture, such as those made of antler, bone, horn, and leather, are discussed quite fully and compared with certain ethnographic specimens from North Europe. Nets, baskets, mats, and textiles are objects rarely preserved for the archaeologists but many have been recovered under unusual circumstances, such as the numerous European salt-mine finds. Of wool, there is no trace in Neolithic times. The earliest occurrences are in Bronze Age sites, which fits well the known fact that sheep were not an important domesticated animal in earlier-than-Bronze-Age times. Clark avers that Bronze Age wool was brown, but white fleece becomes "a progressively larger proportion" from Roman Iron Age to the Viking period.

Despite the concentration of interest of the prehistorian upon the relationship between any given peoples and their immediate surroundings, trade is not actively confined to the later peoples. In Neolithic times both farmers and hunter-fisher folk carried on trade. In fact it appears that certain merchants continued to make a living among the hunters and fishermen in the axe trade after this was no longer profitable among the later farmers. If trade played a significant role in neolithic economy, particularly in the supply of axe blades, it was quite vital to that of the Bronze Age. All during Neolithic and Bronze Age times amber from the western shore of Denmark moved south to the

Mediterranean to fill the needs of Myceneans and others. Temperate Europe remained quite marginal to the Mediterranean despite these contacts. Clark finds ". . . it was not until the late fifth and fourth centuries that classical influence transformed Celtic society, stimulating the art distinctive of LaTene culture and introducing in due course a whole series of technological changes, . . ."

Most of the foregoing is drawn from Clark's principal work *Prehistoric Europe: The Economic Basis.* It epitomizes the contributions the archaeologist may make to geography, or rather it indicates the scope of the possible contributions of geography to prehistory. In another brilliant work, *Excavations at Star Carr,* Clark has shown how practical are some of these applications.[3]

In this volume Clark has done what may be considered the finest report of an archaeological research problem with a geographic orientation. As early as 1932 the Fenland Research Committee was formed for the avowed purpose of furthering cooperation between the archaeologists and natural historians. The Star Carr study is a finished product indicative of how successful has been this endeavor. Clark earlier had concluded that the most direct information about the way of life of Mesolithic man was to come from "excavating in water-logged deposits," such as bogs or similar conditions of settlement. Physical conditions of this order would best preserve organic remains that would most vividly tell something of the total life-way of the Mesolithic settlers. Star Carr ideally met these requirements.

The Star Carr report indicates how many of the methods of the geographer are of value to the archaeologist. By distribution diagrams of several kinds of objects, site size was determined. Many samples of fossil tree and herb pollen revealed the general position of the site in the vegetational sequence or climatic sequence. Although actual plant remains recovered in the archaeological level of the site would indicate that plants were not a vitally important source of food, yet every shred of evidence was wrung from the seeds, leaves, fragments of bark, and the like that gave clues. Far more indicative of the food supply were the animal bones which occurred in abundance. Clark used counts of every specimen, determined probable "total clean-carcass weights," estimated caloric needs for the probable number of persons of the Star Carr community, and arrived at a time span for the site of about six and one-quarter years.

The Star Carr study may be taken as a model for every geographer and archaeologist to read and strive to emulate in his writings. The details of the use of pollen analysis with many diagrammatic representations of results, the critical examination and fruitful results that are obtained from detailed soil and earth stratigraphy analyses, and the particulars of life-ways that were obtained from faunal-remains studies, all give one an awareness that Clark used just about every avenue of research now available to the prehistorian.

The volume, *Excavations at Star Carr,* also is one of the finest examples of the work of the Cambridge University Press. Already enjoying a reputation for fine workmanship in printing and binding, the Press has apparently increased its standards of excellence in recent years, and the volume reflects it. Its quarto format, easily readable type, numerous halftones and line drawings make this a book beyond the price scope of most scholars in the United States were it published here. It and, to the same degree, Piggott's *The Neolithic Cultures of the British Isles,* are far and away beyond most printers' productions here in recent years.

A publication such as that on Star Carr was possible, in part, because Clark used the most expert help available to him. The faunal remains were identified in great detail as to types and portions of bones by two British Museum of Natural History co-workers, Dr. F. C. Fraser and Miss J. E. King. The pollen and other vegetational materials were analyzed by two internationally known Pleistocene research fellows of Cambridge, Dr. H. Godwin and Mr. D. D. Walker. Recently, it has been reported mammalogists with United States museums consider it a waste of time to identify faunal remains since "nothing is ever done with the information." This reviewer has devoted many hours to such faunal determinations without evidence that the material would contribute to any understanding to man in the New World.

Examples of the use of faunal remains, of pollen diagrams, of distributional studies, and of the several other devices illustrated above may be found in Piggott's works, in Childe's field studies, and in the works of several other British prehistorians as well.[4] Piggott's use of land snails from archaeological sites in the South English Chalk downland has cast a fresh light on the problem of prehistoric ecology of the Downs. This topic might be expanded much further, but with little profit.

Perhaps the foregoing review would force the conclusion that this form of interdisciplinary research is absent in the United States. This is virtually true for archaeology in America and, it seems evident, for geography as well.[5] In general, most archaeologists argue that we have insufficient detailed knowledge of our prehistory as yet. Pollen studies have lagged behind those of the Europeans, but again the incentive is different because the physical conditions seem to many to present vastly different problems rather than "roughly similar" ones. Whereas the expansion of ice in Europe wedged the retreating vegetation zones against an east-west mountain chain, the Alps, in North America there was no such elevation; hence the plant succession is different. Nonetheless, there have been few attempts to trace the alteration in vegetation zones in the Pleistocene of the New World. Another factor is that continuous occupation of man in post-glacial times

[3] *Excavations at Star Carr: An Early Mesolithic Site at Seamer near Scarborough, Yorkshire.* New York: Cambridge University Press, 1954. 200 pp., 24 plates, 80 figures.

[4] A notable specimen is Joseph Raftery, *Prehistoric Ireland* (London: Batsford, 1951).

[5] One of the few examples of an attempt to utilize a many-fold approach to an archaeological problem is Frederick Johnston's *Boylston Street Fishweir.* (Papers of the Robert S. Peabody Foundation for Archaeology, Vol. II, 1942). Several paths were independently pursued—coastal subsidence, pollen, marine mollusks, etc.—and the whole integrated into one comprehensive account.

in North America has not been demonstrated, although evidence mounts in that direction.

American archaeologists think their European colleagues have done all the heavy spade work in their field and are now polishing up the details. On the contrary, the recognition of a cultural stage, the Mesolithic, differing from either Paleolithic or Neolithic but not necessarily intermediate, was a great lesson to European archaeologists. It vaulted them from the typological rut of the museum antiquarian and made them aware of many new applications of their data.

In the United States there is a faint stirring among archaeologists.[6] However, the cultural geographer most ideally fits the role exemplified by Clark, Childe, Piggot, and others. Geography alone relates "site" and "culture." Geography is physical—space, distances, depths, climates, vegetation, and resources. Geography is cultural—man's alteration of the face of the earth. The relationship of these two aspects of the cosmos, the physical and the cultural, is ultimately the goal of all sciences. Cultural geography has made a beginning toward attaining recognition as the synthesizing discipline in the field.

Selected Contributions of Childe, Clark and Piggott

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[6] For example, see the ecological studies of Julian Steward and the recently published *Prehistoric Settlement Patterns in the New World* (Viking Fund Publications in Anthropology, No. 23, 1956).

ECONOMIC DEVELOPMENT IN CEYLON AND MALAYA

In the past several years the literature concerned with the economic developmental problems and prospects of a number of countries, most of them falling into the "under" or "lesser" developed category, has been enriched by the published reports of the International Bank for Reconstruction and Development (the World Bank). These reports have consisted of massive monographs composed of the collective findings and judgments of teams of experts gathered from a number of countries, chiefly those of Western Europe and the United States, but including others as well. The objectives of these studies have been basically "remedial" and designed to facilitate the formulation of economic policy within countries confronted with formidable developmental problems. For the most part the reports do not pretend to be comprehensive studies, but rather the results of surveys completed in a short period of time (averaging about 3 months in the field). The publications have been of generally high but differential quality, frequently none too well integrated, generally reflecting a "Western" point of view, always full of valuable data previously difficult of access to students and scholars. Two particularly interesting reports covering two Asian tropical countries in the British Commonwealth with overlapping problems have been completed,[1] one on Ceylon, an independent state seeking a decreasing degree of dependency on Britain, a second on Malaya, which is scheduled for independence on the 31st of August, 1957.[2]

These two volumes contain the detailed reports of advisory missions, organized by the World Bank, which respectively visited Ceylon at the end of 1951 and Malaya early in 1954. Both missions were invited by the governments concerned to assess the potentialities for further economic development within their territories and to make recommendations for practical measures to promote the economic and social betterment of their populations.

[1] International Bank for Reconstruction and Development. *The Economic Development of Ceylon.* Baltimore: Johns Hopkins University Press, 1953 (2nd printing, 1956). xxxii and 829 pp. Maps, graphs, tables, index. 6 × 9. $7.50.

International Bank for Reconstruction and Development. *The Economic Development of Malaya.* Baltimore: Johns Hopkins University Press, 1955. xix and 707 pp. Maps, graphs, tables, appendix, and index. 6 × 9. $7.50.

[2] The Federation of Malaya is to acquire independence on that date under the tentatively chosen name, "Malaysia." The Crown Colony of Singapore is to remain a separate political entity, also proceeding toward independence but at a slower pace.

Both the mission to Ceylon, headed by Sir Sydney Caine, and that to Malaya, headed by Sir Louis Chick, contained fourteen members, three of whom, Francantonio Biaggi (Adviser on Power), John F. V. Phillips (Adviser on Agriculture), and William M. Gilmartin (Economist) were common to the two. The reports, which are of roughly equal length, approach their task in very much the same way, beginning with a brief statement of the over-all problem as the mission envisaged it and then going on to consider at greater length the resources available—both physical and human—and the prospects and problems of the various sectors of the present-day economy, finance, education, and public health. In both cases a great mass of factual data is included, and the mission's recommendations are stated with commendable clarity. Both are well supplied with maps and statistics, but of the two the volume on Ceylon is much the better in general layout and readability.

The two areas in question also present many points of similarity, despite the facts that Ceylon is further advanced politically, having already achieved independence from British rule, and is untroubled by the kind of Communist-inspired terrorism which imposes such a heavy financial burden on Malaya. Both have populations of roughly comparable size (7–8 millions) whose rate of increase has recently shot up to disturbingly high levels (Ceylon 2.8 percent a year, Federation of Malaya 3.2 percent, and Singapore 3.8 percent), and while both enjoy standards of living which are at present distinctly above those of most neighboring lands, both are precariously dependent on overseas sources for more than half of their basic food requirements and on a narrow range of uncertain primary products for their exports.

Faced with such situations it is perhaps scarcely surprising that neither report has any revolutionary suggestions to make and both seem for the most part inclined to endorse opinions previously expressed by other experts without adding much new evidence in their support. While original work of this kind can hardly be expected in such circumstances, it is a valid criticism of both reports that they do not adequately acknowledge the sources on which they have been based.

For Ceylon the mission places primary emphasis on the agricultural sector and sees in colonization of the Dry Zone the main short-term answer to the problem of population increase. Nevertheless it stresses both the need for nation-wide education in family planning and the importance of proceeding cautiously with land settlement schemes pending the prosecution of further research into such matters as soil management and the extent of available water resources. At the same time it urges the need for achieving the greatest possible efficiency in the production of the three main agricultural exports, tea, rubber and coconut products, though it sees little prospect of any important expansion in the acreage under these and indeed clearly advises against it in the case of rubber for which it considers the future market will be increasingly difficult.

Industrial development is explicitly regarded as the second string, though in the more distant future adequate expansion of the national income will only be achieved if a much larger proportion of the country's labor resources are employed in that sector. With this end in view, therefore, the mission recommends the building up of various small-scale industries, particularly those using local raw materials and not requiring a high level of technical skill. Specifically, it lends its support to proposals already made for establishing caustic soda, DDT, ilmenite, and sugar plants, but soberly advises reappraisal of the more flamboyant projects for setting up steel, paper, and fertilizer factories.

While such advice may be unwelcome in some nationalist circles, there can be little doubt that the mission is on firm ground economically in recommending concentration at this stage on a series of small-scale industrial units rather than on a few spectacular modern installations. For the former, besides costing much less, will contribute significantly to the spread of a knowledge of industrial techniques, while the latter would make excessive demands on existing reserves alike of capital and technical and managerial skills. Meanwhile the country's power supplies will need to be extended, and the mission also recommends that much greater attention should be paid to vocational and technical education.

In short, the pattern of development recommended for Ceylon is a textbook example of current economic orthodoxy and, provided the rate of population increase is brought within bounds and no foolish squandering of resources takes place, the mission seems reasonably confident about the country's economic prospects.

The economic future for Malaya likewise seems to inspire Sir Lewis Chick's mission with what the diplomatists call "a spirit of cautious optimism," though the present reviewer must confess to more difficulty in sharing these particular sentiments. While the report rightly stresses the importance in the economy of both the entrepôt trade of Singapore and Penang and the now considerable range of secondary industries in various parts of the country, it is clear nevertheless that Malaya's dependence on rubber and tin, which together account for 85 percent of its domestic exports, is the decisive factor in the situation.

Both of these commodities, it is admitted, suffer from serious uncertainties, that in rubber arising from the competition of the synthetic product and that in tin from long-run technological economies in world utilization. Indeed, the Mission believes that any substantial expansion in Malayan tin production is unlikely in the foreseeable future, but on the outlook for rubber, which clearly constitutes the $64,000 question, its conclusion is markedly more favorable. Thus, "Cost data from a representative cross-section of rubber estates indicate that the production of high-yielding rubber on well-managed estates could continue to compete profitably with synthetic rubber even if prices of the latter were to fall well below present levels. Small holdings of high-yielding rubber cultivated mainly with family labor would be even less vulnerable to lower synthetic rubber prices." Since no other crop can be found which offers comparable cash returns from the greater part of the land now under rubber, the mission goes on to recommend a massive program of replanting

with high-yielding rubber as the country's "most urgent development priority."

It is possible that this advice, which in general is in line with the policy already being followed by the Federation government, will prove to be essentially sound and that over the next 30–35 years the world market for rubber will be large enough to absorb a greatly increased Malayan output besides that of other Southeast Asian producers and the expanding synthetic factories of the West as well. But when one recalls the progress made in synthetic rubber during the past 30–35 years and the history of other natural products such as indigo, quinine, and silk, which have come under the competition of man-made substitutes, one may be justified in doubting whether the cost data referred to provide an adequate basis for this assumption and whether it is wise to place so many eggs in so problematical a basket. Indeed, bearing in mind the Ceylon mission's comments on the prospects for natural rubber, one is bound to wonder whether this advice is based on positive confidence in the future of natural rubber or simply on the virtual impossibility of finding any remotely comparable alternative to replace it in this dangerously over-specialized economy.

For the rest there is much sound sense in the Mission's recommendations. Although once again family planning is advised as a matter of urgency, it is foreseen that the population will be at least double its present figure in 25 years' time. Such a growth makes it imperative both to extend the acreage under rice cultivation and to create new opportunities for employment in secondary industry. So far as the prospects for the former are concerned, the Mission seems to be somewhat more hopeful than a study of the Federation's own Draft Development Plan of 1950 would warrant, though it is possible that experience gained in the intervening years may go some way to justify this. Certainly as regards industry the mission is right to stress the considerable resources which Malaya possesses in skills, enterprise, and business experience which, if properly used, could be assets of the greatest importance.

Perhaps the most interesting feature of the report is its almost unconscious assumption that, notwithstanding the legal existence of the two quite separate governments of the Federation of Malaya and Singapore, respectively, British Malaya is nevertheless one country whose problems need to be tackled as a whole and not in two watertight compartments. In this connection the recommendation that a Central Bank be established for the whole country is undoubtedly an important step in the right direction.

Nevertheless, a perusal of the report leaves one with the uneasy feeling that the future it envisages is little more than the product of a pipe dream. For, quite apart from the all-important question of the demand for natural rubber, the immensely complicated communal problem is scarcely allowed to obtrude itself into the argument, except rather indirectly in the discussion of land tenure and Malay Reservations. Yet almost every recommendation that has been made will be assessed by the local population largely in terms of its communal implications and in several cases these are likely to be of far-reaching significance. Thus, for example, the development envisaged in the secondary industries appears almost bound to increase the much resented economic predominance of the Chinese, and for this reason many of the measures recommended in order to foster it would be strongly opposed by the Malays who are still the predominant element in the Federation electorate.

This failure to take into account the probable reaction of the local population is indeed the besetting weakness of the report, and the same criticism may also be levelled against those sections of the Ceylon report which deal with peasant agriculture and colonization.

In part, no doubt, this is a natural consequence of the limited facilities which exist for acquiring a worthwhile understanding of a country's outlook in the course of a hectic fact-finding visit of only a few months' duration. Again it can be argued that sociological and political considerations lie beyond the terms of reference with which such missions should be concerned, and indeed that the latters' greatest value lies in the impartiality with which they can analyze the situation without being deflected by what may appear to be matters of purely parochial importance.

Up to a point this reasoning is sound enough and, judged by such criteria, both reports may be regarded as distinctly useful case studies of the problems of underdeveloped tropical lands. Nonetheless we should do well to realize that "economic man," who is an abstraction even in the West, is still less of a reality in Asia, and unless we take properly into account the non-economic values by which its peoples are so largely motivated today our prescriptions will have little relevance to what they themselves consider to be their most urgent needs.

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